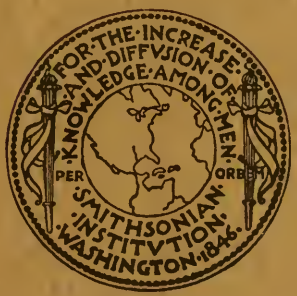
SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 106, NUMBER 15

Thomas Lincoln Casey Fund

LADYBEETLES OF THE GENUS EPILACHNA (SENS. LAT.) IN ASIA, EUROPE, AND AUSTRALIA

(With 27 Plates)

BY
G. H. DIEKE



(Publication 3860)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
JANUARY 20, 1947

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 106, NUMBER 15

Thomas Lincoln Casey Fund

LADYBEETLES OF THE GENUS EPILACHNA (SENS. LAT.) IN ASIA, EUROPE, AND AUSTRALIA

(With 27 Plates)

BY
G. H. DIEKE

(Publication 3860)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
JANUARY 20, 1947

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

CONTENTS

Thomas Lincoln Casey Fund

LADYBEETLES OF THE GENUS EPILACHNA (SENS. LAT.) IN ASIA, EUROPE, AND AUSTRALIA[1]

By G. H. DIEKE

(With 27 Plates)

INTRODUCTION

About one-sixth of all the described species of the Coccinellidae belong to the subfamily Epilachninae, and almost all these to the single genus *Epilachna.* The members of this subfamily are readily recognized by certain morphological characteristics and are distinguished from the rest of the Coccinellidae not only by these structural differences but also by marked differences in their food preferences. The true coccinellids are carnivorous, feeding on other insects; the epilachnines and psylloborines, on the contrary, are phytophagous, the former feeding on leaf tissue, the latter on fungus spores. The species of *Epilachna* feed almost exclusively on leaves of plant species belonging to Solanaceae and Cucurbitaceae, with a few species attacking plants of other families, particularly the Fabaceae and the Compositae. As many of our important cultivated plants, such as potato, tomato, squash, and bean, are members of these plant families and are at times subjected to devastating attacks by species of *Epilachna,* the genus may be considered as economically one of the most important among the beetles.

Reports from China have told of the destruction of whole potato crops by *Epilachna* beetles (Reh, 1913). In Australia they are among the worst enemies of tomato, eggplant, and squash, and similar conditions prevail wherever these beetles are found. The example of *Epilachna varivestis* Mulsant, the Mexican bean beetle, in the United States has shown that the invasion of some species into new territory may be expected with devastating effects. A thorough knowledge of the genus is therefore of great practical importance.

At the time (1837) when Chevrolat split off the genus *Epilachna* from the by that time unwieldy number of species of the original

[1] This is the sixth contribution to be published by the Smithsonian Institution under the Thomas Lincoln Casey Fund.

genus *Coccinella,* only isolated descriptions of species of this genus had appeared. Redtenbacher (1843) apparently was the first to call attention to the fact that the species of this genus are phytophagous in contrast to the majority of the other coccinellids that feed on plant lice. He also was the first to give a description in words of the morphological characteristics of the genus. Mulsant, in the big monograph "Species des Coléoptères Trimères Sécuripalpes" (1850), described a large number of new species and brought the known number from 37 to 152. He was also the first to try a systematic grouping of the species of the whole world. The only attempt to do this after Mulsant was made by Crotch in his revision of the Coccinellidae (1874), when the number of species had grown to 200. Whereas Mulsant's monograph suffers from lengthy descriptions and the repetition of not very important details, Crotch's work, on the other hand, is rather sketchy. After Crotch's revision no further account of the genus as a whole has appeared—only descriptions of new species scattered widely over the literature. Korschefsky's Catalog (1931) lists 457 species of *Epilachna,* and a few have been described since.

Mulsant and Crotch's descriptions and identifications of the species, and even more the earlier ones, are almost completely based on superficial characters like color and spot patterns. It has turned out since that in many genera of the Coccinellidae coloration is not a safe criterion for the fixation of a species, as it may vary widely in one species or be almost the same in two different species that are not even closely related. Nevertheless, most of the subsequent descriptions were chiefly based on coloration, probably partly because morphological characters that can be observed easily tend to be very uniform throughout the genus.

The situation that confronts the student of the genus is therefore very unsatisfactory. In order to identify a species he must look through descriptions scattered through a large number of periodicals, many of them very difficult of access to the average entomologist. Even when he succeeds in collecting all the descriptions, and after he has taken the trouble of reading each one, he finds that in many cases it is totally impossible to identify the species from the description because the latter may fit a number of allied species equally well, or because it may not fit the particular specimens at all, as they may deviate in unessential details of coloration from the type. I found this particularly true when, on Dr. Chapin's suggestion, I tried to identify the extensive material from the Philippines in the

United States National Museum. A thorough revision of the genus seems to be the only satisfactory remedy. The present paper is the first contribution to such a revision.[2] It deals with the species from Europe, Asia, the Indomalayan Archipelago, Australia, and the Pacific Islands. The material from the Philippines, which contains the Baker collection, is probably more complete than anything from this locality ever gathered together before. The material from China is also rather extensive, with long series of some species. There is considerable material from Java, the South Pacific Islands, and British India, and a more scattered representation from the rest of the region.

Although a complete revision of the genus must wait until a detailed study of the African and American species will have been accomplished, the present paper hopes to make it possible that in future the species with which it deals may be identified without much uncertainty. That is very desirable because of the great economic importance of several species and because the inability to recognize them has caused some confusion in the accounts of their biology. Unfortunately, even for the restricted region with which we are dealing, some of the species had to be left out, as I was unable to obtain them, and I have included in this paper only material on the morphology and taxonomy I have been able to check by personal observation.

The analysis had to proceed almost exclusively along morphological lines, as information on the geographic distribution and the biology of the genus is in general yet too scanty to enable one to treat the species as biological entities rather than to define them by morphological characters. Such a morphological analysis, however, is the necessary prerequisite for all further studies. As many of the older descriptions, perhaps most of them, are not sufficient to enable one

[2] Although after Crotch's Revision no further general study of the genus *Epilachna* has appeared, there are a number of monographs of the faunas of certain more restricted regions that have included the genus *Epilachna*. However, those of Europe or North America are of little help because of the very restricted number of species occurring in those regions. The home of the genus is definitely in the Tropics, and only feeble branches of it extend into the more temperate regions. Sicard (1907) gave a synopsis of the species of Madagascar, Fauvel (1903) one of New Caledonia. Mader's "Die Evidenz der palaearktischen Coccinelliden" (1926) contains 29 species. However, in most cases he gives only a copy of the original description and in all cases restricts himself chiefly to coloration and maculation, which, as mentioned before, are not sufficient for a definition and the recognition of the various species.

to recognize the species beyond any reasonable doubt, I have endeavored to give new descriptions embodying such characters by which the species may be recognized without question in the future. As the type of none of these species is available at the present time, the names I have attributed to some of them may be in error. If that should prove to be the case, no great harm is done, as the error can easily be rectified if the types can be compared with the new description.

As in so many other genera of the Coccinellidae, the male genitalia have proved a great help in the study of the genus, and without them no disentanglement of some of the more closely allied species would have been possible. Very little systematic use has previously been made of the genitalia for taxonomic purposes in *Epilachna*. Weise (1900) described those of a few species, and even though he omitted figures, it is easy to recognize definitely the species he had before him. In later descriptions he unfortunately abandoned the use of the genitalia and only occasionally does he or other authors refer to their structure. The female genitalia also proved very valuable.

I should like to express my appreciation to Dr. E. A. Chapin, curator of insects of the United States National Museum, not only for suggesting this study and making available to me the complete material on *Epilachna* in the National Museum, but also for continued advice and helpful suggestions. My thanks are also due to H. S. Barber, of the National Museum, for helpful discussions; and to E. T. Cresson, Jr., of the Academy of Natural Sciences of Philadelphia, Dr. M. A. Cazier, of the American Museum of Natural History, and Dr. E. C. Zimmermann, of the Bernice P. Bishop Museum, for valuable help through the loan of material from the collections in their charge. To Prof. Th. Dobzhansky I am greatly indebted for a number of specimens and some interesting discussions.

After this paper had been completed I had the opportunity to study a number of additional specimens. These came partly from the Museum of Comparative Zoology and were kindly put at my disposal by Prof. Nathan Banks, partly from entomologists attached to the Armed Forces in India and the Pacific and made available to me through the cooperation of Dr. Chapin. The material contained a number of new or hitherto unavailable species which could be added at the appropriate places without upsetting too much the original scope of the paper. The male genitalia of the added species, where available, are illustrated on plates 26 and 27.

THE GENUS EPILACHNA AND THE SUBFAMILY EPILACHNINAE

The genus *Epilachna* was first proposed in 1837 by Chevrolat in the third edition of the Dejean catalog of Coleoptera.[3] He did not give a description but only a list of species which he included in the new genus. From this its scope was perfectly defined. Hope in 1840 indicated *Epilachna borealis* (Fabricius) as the typical species of the genus. A few years later Redtenbacher (1843) first gave a description of the characters of *Epilachna* in words which agreed in its main aspects with those derived from the species in Chevrolat's list.[4]

Nothing changed in this status except the addition of a great number of additional species until Weise (1898a) did two things.

[3] Some editions bear the year 1836 on the title page. According to Barber and Bridwell (1940), the last part of the second edition which began to appear in 1833 was printed from the same type as the third edition but at a later date. This Mr. Barber concluded from that fact that though both editions were printed from the same type, in many cases the letters in the second edition were damaged while they were undamaged in the third. The second edition was destroyed by fire, and the last part, which contains the Coccinellidae, was added to the second edition after the third was printed.

Chevrolat's list contained the following valid species from the Eurasian region:

chrysomelina Fabricius
11-maculata Fabricius (*argus* Geoffroy)
28-punctata Fabricius
26-punctata Boisduval (Dejean)
signatipennis Boisduval (d'Urville)
obsoleta Olivier
flavicollis Olivier
haemorrhoa Boisduval (d'Urville)

besides a number of American (among them *borealis* Fabricius) and African species.

[4] Redtenbacher's description of the genus *Epilachna* translated from the Latin is: Mandibles multidentate; the teeth laterally serrate; the ligula conical with obtuse apex. Claws of the tarsi bifid, armed with a broad sharp tooth. Body with wings.

As the only species of the genus (he restricted himself to the fauna of Austria), he listed *Epilachna globosa,* now called *Subcoccinella 24-punctata* Linnaeus, which does not fit the description of the genus at all. If we would accept Redtenbacher as the author of the genus *Epilachna,* according to the international code (article 30c), we would have to accept *Subcoccinella 24-punctata* as type of the genus, which would make it impossible to leave any of the other species in *Epilachna.*

First he concluded that the genus *Epilachna* should be attributed to Redtenbacher, as he was the first to give its description. He suggested therefore that everything done preceding Redtenbacher, which means Chevrolat's and Hope's contributions, should be disregarded. Following this he proceeded to subdivide the genus into two parts. Those species that have their tarsal claws provided with a basal tooth he continued to call *Epilachna*, whereas for those species without such a basal tooth he proposed the new genus *Solanophila*. In this he was followed by many workers, whereas others rejected *Solanophila* as a separate genus because it was not always clearly separated from *Epilachna* sensu stricto.

It seems now that quite apart from the question whether the genus *Epilachna* should have been split up into two or more separate genera, Weise's procedure was unjustified in the light of the now generally accepted international procedure of nomenclature. Weise's idea probably was that for the establishment of the genus, as well as of a species, the *description* is of primary importance. An illustration of this attitude is contained in the following passages, translated from Reitter (1908, p. 27) referring to description and types of a species.

> Since priority of a species can be obtained only by the accomplished description of it, for the study of a species only the description should be pertinent, for it is lasting but the type perishable and not recognizable as such under all circumstances . . . Types which do not agree with the description must not be considered as such even if they originate from the author . . . The statements of the description must be taken into account in the first place, and the requisition of the type should only have the purpose of ascertaining the correctness of the statements in the description—that always has been the main purpose—and to examine on the type those properties about which the author made no statements, because at the time when he made the description the importance of such special data had not yet been recognized.

With this attitude, which very likely was also that of Weise, sooner or later serious difficulties are encountered, of which the case of *Epilachna* is a typical example. For Redtenbacher's description of the genus agrees neither with Chevrolat's conception of it, as it obviously was meant to do, as species like *borealis* Fabricius and *flavicollis* Thunberg would be left out, nor with the only species that Redtenbacher himself cited. To avoid confusion resulting from such a state of affairs, the International Rules of Zoological Nomenclature were set up, which make the type (more particularly the holotype) the primary thing to which the name of a species is fixed, and similarly the genotype fixes permanently the name of a genus. For the

selection of the name of a genus and its type, the following articles of the International Rules apply:

ARTICLE 21.—The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description, unless it is clear from the contents of the publication that some other person is responsible for said name and its indication, definition or description.

This unquestionably makes Chevrolat the author of the genus, as he was the first to publish, and through the list containing valid species belonging to the genus, gave an indication which served in fact better to characterize the genus than Redtenbacher's later description, and all authors until Weise (1898) and many since have accepted the genus in Chevrolat's sense and not in that of Redtenbacher.

For the selection of the genotype, in the case that the original author does not indicate a type species, the rules are:

ARTICLE 29g.—If an author, in publishing a genus with more than one valid species fails to designate (see a) or to indicate (see b, d) its type, any subsequent author may select the type, and such designation is not subject to change. (Type by subsequent designation.)

Hope (1840) explicitly designated *Epilachna borealis* (Fabricius) as the typical species of the genus. As Hope fulfilled all other requirements of the code, his designation is perfectly valid and binding.

When a valid genus is divided into two or more genera, the International Rules provide:

ARTICLE 29.—If a genus is divided into two or more restricted genera, its valid name must be retained for one of the restricted genera. If a type was originally established for said genus, the generic name is retained for the restricted genus containing said type.

When Weise in 1898 divided the old genus *Epilachna* into two genera, he retained the name *Epilachna* for those species that do have a basal tooth on their tarsal claws and gave the new name *Solanophila* to the species without such a tooth. The division of the genus was made solely on the basis of the presence or absence of this basal tooth. However, as *borealis* Fabricius, the type of *Epilachna,* has toothless claws, article 29 makes it mandatory to leave the name *Epilachna* with the restricted genus containing the type that Weise had, however, called *Solanophila*. Therefore, *Solanophila* Weise and *Epilachna* Chevrolat are identical; in other words, *Solanophila* must be regarded as a synonym of *Epilachna* and cannot be used for any other genus.

So far this touches only the question of whether *Solanophila* is a

valid *name,* not whether the separation of the old genus *Epilachna* into two or more genera is justifiable. The subdivision of such a bulky genus with almost 500 species is certainly desirable. The question of whether it can be carried out without ambiguity can, of course, be decided only after an examination of the species of the whole world. An examination of the species of Europe, Asia, and Australia indicates a natural separation into two well-characterized genera with approximately the same boundaries in this restricted region as Weise proposed for his two genera *Epilachna* and *Solanophila.* Besides the presence and absence of the tooth on the tarsal claws on which Weise based his separation exclusively, the species with toothed claws (with rare exceptions relegated to the genus *Afidenta*) have the sixth visible abdominal segment of the female divided longitudinally, while the species with toothless claws show usually no sign of such a separation. If the biology of *Epilachna admirabilis* Crotch is typical for the rest of the toothless part, there is also an important difference in life habits, as *admirabilis* hibernates as larva, whereas as far as is known the toothed species hibernate as adults.

If, also, the American species are taken into consideration, the matter is less simple, and an inclusion of the African species may complicate matters even more. The American species *E. borealis* (Fabricius), the genotype of *Epilachna,* has toothless claws but has the sixth abdominal segment of the female divided. The question of which of the Eurasian subdivisions should retain the name *Epilachna* rests therefore on whether the structure of the claws or the structure of the female sixth segment is considered more important to make it the key character of the two genera. In order to change as little as possible in the present nomenclature, I shall adopt the division of the sixth segment of the female as the distinguishing character, which makes the toothed species congeneric with the type *borealis,* so that they will retain the name *Epilachna.* For the Eurasian species with undivided sixth female segment and toothless claws (equivalent to Weise's *Solanophila*), I propose the new name **Afissa.**[5]

[5] It is quite likely that a closer examination of the American and African species will make it necessary to subdivide into more than two genera or that no subdivision at all should be carried out. In that case *Afissa* may at least be retained as a subgenus. *Epilachna varivestis* Mulsant would belong to *Afissa.* There are also South American *Epilachna* with toothed claws like the Asiatic ones.

The genera of the subfamily Epilachninae in Europe, Asia, and Australia may now be characterized as follows:

GENERA OF EPILACHNINAE (WITH GENOTYPES)

Character	*Afidenta* (*mimetica*, new)	*Epilachna* (*borealis* Fabricius)	*Afissa* (*flavicollis* Thunberg)	*Subcoccinella* (*24-punctata* Linnaeus)	*Cynegetis* (*impunctata* Linnaeus)	*Epiverta* (*chelonia* Mader)	*Ballida* (*brahmae* Mulsant)	*Macrolasia* (*arcula* Weise)
Sixth abdominal segment of female (*s*-split, *e*-entire)	*e*	*s*	*e*	*e*	*e*	*e*	?	?
Tarsal claws (*s*-single, *d*-double, *t*-with tooth, *u*-without tooth)	*d-t*	*d-t**	*d-u*	*d-u*	*s-t*	*d-u*	*s-u*	*d-u*
Epipleurae (*h*-horizontal, *v*-vertical, *u*-without, *g*-with grooves)	*h-u*	*h-u*	*h-u, g*	*h-u*	*h-g*	*v-u*	?	?
Punctation of elytra (*s*-simple, *m*-mixed fine and coarse)	*m*	*m*	*m*	*s*	*s*	*m*	?	*m*
Distribution (*E*-Europe, *A*-Asiatic Continent, *P*-Polynesia, *Au*-Australia, *I*-Indomalayan Archipelago, *Ch*-China)	*A*	*E, A, I P, Au*	*A, I*	*E*	*E*	*Ch*	*Ch*	*I*

* Rarely without tooth (*haematomelas*, *malkini*).

COMPARISON OF EPILACHNA AND AFISSA

Before giving the description of the individual species, it seems useful to summarize briefly those structural characters most useful for classification and identification. They are naturally those that vary from species to species but stay constant within one species, and these are chiefly emphasized in the following synopsis. It is based entirely on an analysis of Asiatic, Australian, and European species and therefore does not represent the properties of the complete genera for which an analysis similar to that carried out in this paper would be required also for the American and African species, which has not yet been completed. The two genera are taken together because they have many features in common and therefore unnecessary duplication can be avoided. We have thus essentially the old genus *Epilachna* as understood before Weise divided it in 1898. This synopsis also serves to define the use of the various terms. The properties of the other genera of the Epilachninae (characterized in the preceding table), which contain each only one or two species, can then most

conveniently be summarized by stating in which points they differ from *Epilachna*.

Afissa is separated from *Epilachna* by the absence of the basal tooth on the tarsal claw and by the fact that the sixth abdominal segment of the female is not split. The genus *Epilachna* is much more uniform than *Afissa*, and so much finer structural details must be employed to characterize the species in the former. With reasonable care there is not much difficulty in identifying a given species of *Afissa* even from a single specimen, whereas in *Epilachna* that is often entirely impossible from the external appearance alone and often presents difficulties even when the genitalia are available. For that reason the difficulties in identifying the species from the often inadequate original descriptions have been considerable in some groups of *Epilachna*, and several cases had to be left for future research when the types become available. However, only the *names* of such species are in doubt. The characters given in the descriptions and figures will permit a definite recognition of the species at any time.

The *shape* varies from elongate-oval and rather depressed to hemispherical and very convex, with the extremes occurring in *Afissa*. Whereas the shape is a very useful character for the quick recognition of some species or groups of species, it is less suited for the separation of closely allied species, since it varies gradually. Quantitative measurements of the shape have been omitted because dried specimens are often distorted, but the illustrations give an indication of the outline of the species. The *length* varies from 5 to 10 mm. in *Epilachna* and from 3 to 12 mm. in *Afissa*.

Mulsant lays great stress on the way the elytra are rounded at their base and shoulder for his classification of the species of *Epilachna*. I have found this a very vague character, and the fact that Mulsant himself has placed members of the same species in two different classes shows that it is not of great practical value. Some species have a regularly oval shape with the greatest width in the middle; others are attenuated behind, with the greatest width well before the middle.

The *abdomen* presents some very important identification characters, some of which seem to have been overlooked hitherto. The first ventral segment [6] shows the *abdominal lines*, which differ somewhat

[6] In taxonomic papers it has been the custom to number the abdominal segments by calling the *visible* segments Nos. 1 to 5. In the Epilachninae, usually but not always, also the sixth ventral segment is visible in both sexes. If this nomenclature is adopted there is no correspondence with the numbering of the dorsal segments or with the state of affairs in other groups of insects. The

in the various species. In *Epilachna* they are usually complete, i.e., they reach in a complete arc from base to base (fig. 5 A). They are called subcomplete if their outer part does not quite reach the base. They are usually subterminal, i.e., they reach to within about one-fifth of the apical margin of the first segment. The exact extent of their reaching toward the apex is variable within a species, as what appears as the apical margin of an abdominal segment in a dried specimen apparently depends on the state of contraction of the abdomen when the specimen died, and the treatment of the specimen after death. In some species, however, the plates reach only to the middle of the first segment or a little beyond it. This is mentioned specifically in the description of the species. The shape of the abdominal lines may be a symmetric arc with almost uniform curvature. More often the sides, particularly the outer ones, are nearly straight. Occasionally the plates are angulate, i.e., they present a more or less well-defined angle at or near their apex. In *Epilachna* strong departures from the normal shape are rare and gradual, and the shape varies somewhat within a species, so that the abdominal lines are not particularly useful for the characterization of the species. In *Afissa* the variety is much greater and the structure of the abdominal lines may be used often with advantage. The punctation of the first segment in the middle between the abdominal lines usually consists of fine punctures more or less as on the rest of the abdomen. However, in some *Afissa* species (*admirabilis, chapini,* etc.) these punctures are rather big circles diminishing in size from base to apex.

The fifth and sixth abdominal segments present the most useful characters; they usually differ in the two sexes. On the whole the hind margin of the fifth segment tends to be more concave in the male than in the female. In *Epilachna* it is truncate to quite pronouncedly concave (*cuncasticta*) in the male, whereas in the female it is most often truncate, occasionally with a process in the middle (*chry-*

first dorsal segment is always that which carries the first pair of stigmas, and it appears that in the Epilachninae the first two true ventral segments are fragmentary and appear as a membrane and the sclerotized edge of the abdomen. The first visible segment is therefore the third true ventral segment, and in morphological papers it is customary to number the segments in this way. In order to conform to both systems of nomenclature in the present paper, when a segment is called the "fifth ventral segment" the numbering is that of the *visible* segments, whereas when it is called "sternite VII" it is numbered to conform to the true numbering of sternites and tergites. In other words, the first ventral segment is the same as sternite III, etc. For the description of exterior parts, the first way of numbering is customary, whereas the second is used for the description of genital segments.

somelina, fig. 5 H) which makes it appear biconcave, only very rarely (*enneasticta*) slightly concave. In *Afissa* the fifth segment may have a similar structure as in *Epilachna* but often is convex in both male and female, usually but not always less so in the male. In the *convexa* group it may be considerably modified in the male, and this may affect even the fourth and third segments.

The *sixth segment* almost always protrudes distinctly from under the fifth in both sexes (exception *chapini* group of *Afissa*). It is quite different in character from the preceding five segments. Whereas the first five segments are more or less firmly joined together along their whole width, the sixth segment is loosely joined to the fifth so that it can move freely, and it may be more or less protracted from under the fifth. In *Epilachna* it is always split longitudinally into two halves in the female; in *Afissa* it is always without such division and is usually then narrower and more convex than in the male, but may be emarginate as much as to appear bilobed (*convexa*). The male sixth segment in *Epilachna* may have a uniform convex hind margin (fig. 5 A) or may be subtruncate or emarginate (fig. 5 B) and in some species has a definite deep notch (fig. 5 D). In *Afissa* again the variety is larger with the greatest modification in the *convexa* group.[7]

[7] In the average museum specimen the structure of the apex of the abdomen is usually obscured by dirt and the terminal pubescence. Often the abdomen is bent so that its tip is obscured by the elytra, and of course in the European style of mounting the abdomen is completely invisible. The most satisfactory way to remedy this is to remove the abdomen and mount it separately on a piece of cardboard. Often the base of the cardboard triangle on which the specimen is mounted will be satisfactory; otherwise a separate triangle or rectangle may be attached to the same pin under the specimen. In some specimens the removal of the abdomen can be accomplished without relaxing by inserting the point of a dissecting needle or better a lancet point between abdomen and metasternum. Usually, however, it will be safer to relax the specimen first, which can be done quickly by boiling it in water for a few minutes. The abdomen is then put in relaxing fluid and the dirt can be removed gently with a dissecting needle or a small hard brush. The abdomen is then also ready for the removal of the genitalia. For purposes of dissection or for any other purpose, specimens collected in alcohol or put in alcohol or relaxing fluid immediately after death and then dehydrated and degreased before mounting are far superior to those mounted and dried in the conventional way. Specimens prepared in the former manner will be just as good as fresh specimens no matter how many years have elapsed. Specimens that were not degreased sometimes are so much covered with a mixture of grease and dirt that all structural details and even the colors are hidden. Immersing such specimens for a few days in a degreasing fluid such as carbon tetrachloride, chloroform, or benzene, will usually improve them tremendously.

In judging the apex of the sixth male segment, it is important not to confuse it with the apex of the seventh segment, which occasionally slightly protrudes.

The normal form of the *mandibles* in *Epilachna* is as follows (fig. 1 A-C) : The basal tooth present in the other subfamilies of the Coccinellidae is always absent in the Epilachninae. There is an apical tooth and two lateral teeth, the former larger than the latter. The

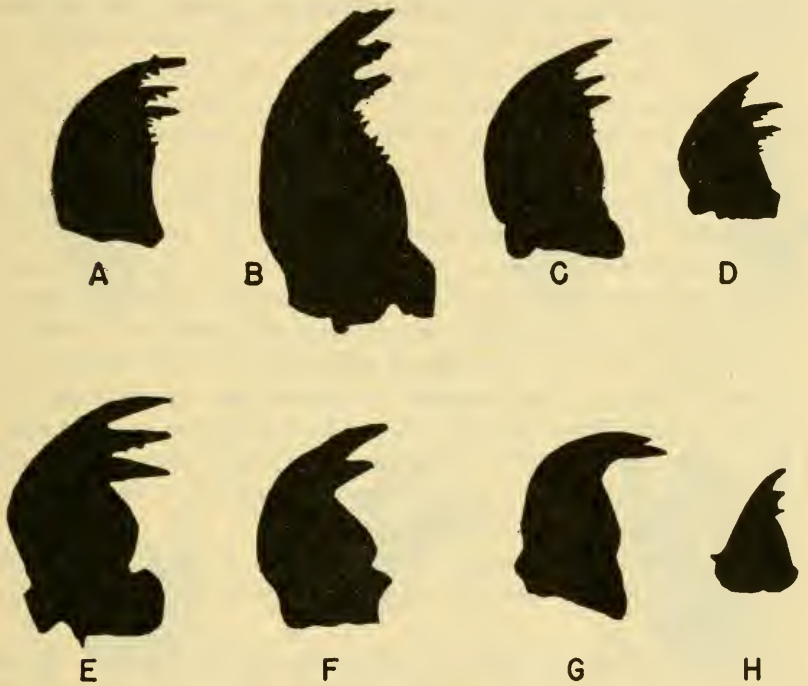


FIG. 1.—Mandibles.

A, *Epilachna niponica;* B, *E. diffinis;* C, *E. argus;* D, *Subcoccinella 24-punctata;* E, *Afissa flavicollis;* F, *A. dumerili;* G, *A. coccinelloides;* H, *Cynegetis impunctata.*

apical tooth seen from in front shows that it consists of three parts, with the lower and upper parts less well developed than the middle. In addition, the lateral edge of the mandibles beyond the two lateral teeth is covered with a number of very small teeth (dentules), which also cover the edge of the three main teeth. There does not seem to be a great deal of variation (not every species has been examined). The lateral teeth are sometimes smaller compared to the apical teeth in some species than in others. In *chrysomelina* the second lateral

tooth is considerably smaller than the first, while in the other species they are of about equal size. In judging the structure of the mandibles one must keep in mind that individuals which have done much feeding may have some of the details worn off. Therefore it does not seem advisable to use such details as the shape and size of the dentules for diagnostic purposes.

In *Afissa* the general structure of the mandibles is similar to that in *Epilachna,* but the individual variations are greater. The dentules usually are less pronounced and often absent. The two lateral teeth may be of the same size as the apical tooth (*flavicollis,* fig. 1 E), or they may be smaller (*admirabilis*). One of the lateral teeth may be missing (*dumerili,* fig. 1 F) or even both (*coccinelloides,* fig. 1 G). In the latter case the mandibles resemble superficially those of the subfamily Coccinellinae, although a closer inspection reveals that we are dealing with a modified form of Epilachninae mandibles. (The basal tooth is always absent.) Species which hardly can be told apart in external appearance may show the extremes in mandible structure. In such cases the mandibles are a good diagnostic character. However, they hardly ever can be examined sufficiently without dissection or at least relaxing. It is reasonable to assume that a pronounced difference in mandible structure is caused by a difference in food habits. The genus *Afissa* would furnish some interesting examples for testing this assumption. At present, however, nothing is known about the food habits of such species.

Afidenta bisquadripunctata Schönherr has a peculiar mandible structure different from that of any of the other species of the subfamily.

The *tarsal claws* of species of both genera are always bifid. In the genus *Epilachna,* at least in our restricted region, they are almost always provided with a basal tooth, which is usually triangular (fig. 2 A). In *chrysomelina* it is quadratic (fig. 2 B), and in *guttatopustulata* it is quadratic and has a small toothlike process on the inner apical corner (fig. 2 C). In the species of *Afissa* the basal tooth is always missing (fig. 2 E, F). The inner claw in both genera is wider than the outer one. In the majority of the *Afissa* species the two inner claws of one tarsus are well separated from each other (fig. 2 E). In a number of species, however, they touch each other, and in such cases the inner claw is exceptionally wide (fig. 2 F, G). Cases like this are mentioned specifically in the descriptions.

The *elytra* of the whole subfamily Epilachninae are covered with pubescence of varying length and denseness. In general the pubes-

cence is light of color on the light parts of the elytra and black on the dark parts. There are, however, many exceptions from this rule. Cases where the pubescence is light gray all over are not infrequent. Caution must, however, be observed in using this character for separating allied species, as several cases are known (*sparsa, niponica, diffinis*) where specimens occur with the uniformly light pubescence, together with those with the normal coloring of the pubescence. The specimens with uniformly light pubescence usually can be recognized

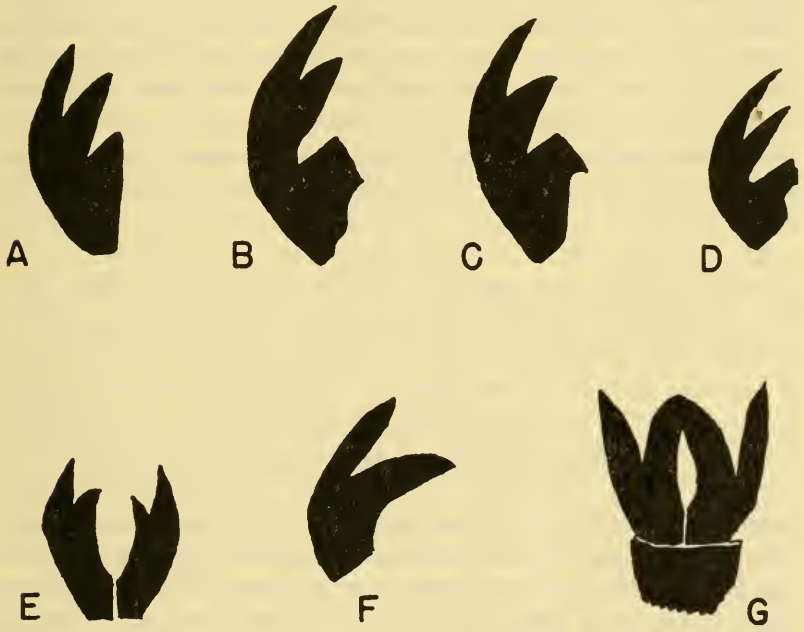


FIG. 2—Claws.

A, *Epilachna diffinis;* B, *E. chrysomelina;* C, *E. guttatopustulata;* D, *Afidenta mimetica;* E, *Afissa flavicollis;* F, G, *A. quadricollis.*

immediately by the fact that the maculation stands out less pronouncedly than in normal specimens. Under the microscope care must be taken that reflections from the hairs do not mask the true color. Viewing the elytra at a glancing angle at fairly high magnifications seems to give the best results.

The elytra are always covered with double *punctation.* There are coarse punctures with a larger number of very fine punctures interspersed. The denseness of the punctation and the depth of the individual punctures vary, but this fact is usually not mentioned in the

descriptions unless extremes are encountered or variations useful for the separation of closely allied species. Occasionally the coarse or the fine punctures are almost obsolete.

The apical angle of the elytra may be rounded or show a definite angle (fig. 3). This is often useful for the separation of species otherwise very similar. In many cases, however, the angle is so indistinct that a decision on whether it is there or not is doubtful.

The epipleurae in general show no particular diagnostic characters except in a few species of *Afissa* (*chapini, magna*) where they show definite and deep cavities for the reception of the tips of the hind femora. Such cavities occur also in *Cynegetis* and were used as one of the chief criteria that separated *Cynegetis* and *Epilachna*.

The color and maculation of the various species are subject to great variations within a species, and at the same time, in some groups, there are often no systematic differences between different

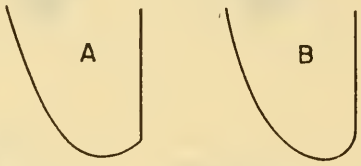


FIG. 3.—Tips of elytra.

A, angle distinct (*sparsa*); B, angle rounded (*28-punctata*).

species. As a rule in *Epilachna* the infraspecific variations are larger than the interspecific ones, whereas in *Afissa* in general the interspecific variability seems to be greater. No reliance at all can be put on the color of the under side. It may vary from completely light to completely dark within a species. In the intermediate stages the sides of the metasternum are dark with the rest of the under side light, then the whole metasternum and parts of the abdomen get dark. The under side of the prothorax and the sides of the abdomen usually keep their light color last. The legs and mouth parts behave in the same way as the rest of the under side.

The original descriptions of most of the *Epilachna* and *Afissa* species were almost exclusively based on the color pattern of the upper side. The fact that this is so variable within a species and so similar in different species has caused a great deal of confusion and presents the chief difficulties to a rational analysis of the two genera. As mentioned before, the situation is much worse in *Epilachna* than in *Afissa*. Neither the number of the elytral spots nor their size,

shape, or position can be regarded as safe characters for the identification of species, and a similar situation prevails with respect to the pronotal pattern. Though it is true that in many cases conclusions derived from the spot pattern will obscure rather than clarify the relations between the species, the spot pattern is still one of the most valuable criteria even for the analysis of the genus *Epilachna*. It may not be possible in many cases to recognize a single specimen by its spot pattern, but the trend and range of the variations are quite characteristic for the species, particularly if one restricts himself to a definite locality. Details of the maculation and its variation will be discussed under the various groups.

Male genitalia.—As in so many other groups of the Coccinellidae and other beetle families, the male genitalia have proved an excellent criterion for the separation of closely allied species, and without their help the identification of many species and the separation of some of the closely allied groups would be hopeless. In the genus *Epilachna* the majority of the species have very similar male genitalia, and so finer details must often be made use of for their separation. In *Afissa* there is so much greater variety of forms that usually even a superficial inspection will be sufficient for positive identification. First a brief description of the normal form of the male genitalia in *Epilachna* will be given, with those details of their structure emphasized which are particularly useful for diagnostic purposes, and attention will be called to the deviations that may occur from this normal form. Details of this will be found in the figures of the various species and under the various groups of *Afissa*.

The three main parts of the male genitalia are the penis, the paramera, and the sipho (fig. 123). The penis is a slender tube, straight or almost straight for most of its length, with a lengthwise seam along the middle of its under side.[8]

Near its end the penis is almost always curved up, and the shape of this curvature is often characteristic for the particular

[8] The terminology is that of Verhoeff and Dobzhansky. During copulation the genitalia are extended from the tip of the abdomen so that the middle lobe or penis is lowest and the paramera just above it. In the drawings they are oriented as if the paramera would stick out horizontally and the terms "above" and "below" are used in the descriptions with this position in mind. Actually they point more or less downward. When the genitalia are retracted in the abdomen they lie on their side in the left part of the abdomen. The sipho is led through the penis and in the rest position protrudes just a little from the orifice near the end of the penis. In the active position it can be extended so that it protrudes considerably.

species. At the very tip the penis may curve suddenly again so that a small hook is formed, or it may have a straight point. The sipho is led through the penis and emerges through an orifice, the basal edge of which usually is formed by the edges of the seam gradually diverging apart. The apical end of the orifice is usually rounded. The length and shape of the part of the penis beyond the orifice constitute important characters. On the upper side of the penis near its base between the roots of the paramera there is a very thin knifelike ridge called the basal knife edge. It is very prominent in some species, rudimentary or completely absent in others. Its size seems to be somewhat variable within one species. In most species of *Epilachna* there are erect hairs on the upper side of the penis. The extent and length of this pubescence often presents a good character. Toothlike transverse ridges on the upper side of the penis present in a few species (*niponica, diffinis, dentulata*) are very useful for the identification of those species.

The paramera are two flattened elongate appendages attached at the upper side of the base of the penis. There is not much variety in their shape in the majority of *Epilachna* species. They have usually about the same length as the penis. When their length is significantly different (e.g., *argus*), this difference can be used for the identification of the species. In most species the paramera have a short thorn at their apex (called apical thorn). The presence of this thorn may sometimes be obscured by the dense hairs that line the end parts of the paramera. Occasionally these hairs are of exceptional length and help then to characterize the species.

The *sipho* is a long slender tube of considerably smaller diameter than the penis but of greater length. Normally in *Epilachna* it is curved near its base through an angle of less then 90° and is approximately straight from the basal bend to the apex. In the *guttatopustulata* group (fig. 144) it has a basal bend of about 180° and is greatly modified in the *enneasticta* group (fig. 146). Whenever departures from the normal shape occur they are mentioned specifically in the individual descriptions. The characters most useful for the separation of closely allied species lie at the apex of the sipho. This most often ends in a relatively sharp straight point, just before which, on the side, is a small oval orifice through which the semen is ejected during copulation (fig. 118). However, the apex may have a sharp notch (*28-punctata,* fig. 119) or be emarginate (*emarginata,* fig. 125) or enlarged (*chrysomelina,* fig. 145) or otherwise modified.

In *Afissa* there is no such uniformity in the structure of the male

genitalia and every part may be greatly modified. Details about this will be found in the notes on the various groups of *Afissa* and the descriptions and figures of the species.

Female genitalia.[9]—After Verhoeff (1895) and a few others had described the female genitalia of a few isolated coccinellids, Dobzhansky (1924) gave a synopsis of the genital structure of the females of 55 species of Coccinellidae and showed how the variety of struc-

[9] Because often a positive identification in the Coccinellidae is impossible without an inspection of the genitalia, a few notes on their dissection may be helpful to those unfamiliar with this technique. The technique is essentially that used by workers in the United States National Museum, with a few modifications adapted to the particular situation in *Epilachna*.

First the abdomen is removed as described on p. 12 and, if the whole specimen was not relaxed before, relaxed in boiling water and transferred to a watch glass with relaxing fluid under a binocular microscope at about 10 to 20 times magnification or under a hand lens mounted so as to leave both hands free.

The only instruments needed besides a pair of light forceps with a sharp point are two dissecting needles, one with a straight point, the other with a lancet-shaped point with as sharp an edge as possible. An iridectomy knife will be better but is rather expensive and can be dispensed with.

Male: Make an incision at the left edge of the abdomen and lift the dorsal membranes. The male genitalia are then exposed and can be extracted with the forceps. They should then be cleaned of all nonsclerotized matter with the help of the dissecting needles. The sipho is better pulled out of the penis. The relaxing fluid will dissolve a greasy layer which otherwise might be present. Both parts, as well as the abdomen, are then left to dry and mounted on cardboard pieces so as to permit an inspection from all sides. These cardboard pieces are kept on the same pin as the specimen.

Female: For the extraction of the female genitalia, relax the abdomen and place it in relaxing fluid as for the male genitalia. Then sever the connection between sternites and tergites VIII and the membranes that hold the genitalia to these segments. The genitalia surrounded by nonsclerotized matter can then be taken out. The soft matter prevents a clear view of the genitalia and must be removed. For this purpose, boil them in a microtest tube in a 9-percent solution of KOH. If the soft parts of the genitalia are to be preserved, about 15 seconds is sufficient, and a few trials will give the best time. If only the sclerotized parts are wanted, a much longer boiling time is permissible, which will destroy all the soft parts.

After boiling, place the genitalia for about 10 minutes in a watch glass with water to wash out the KOH. Then transfer successively to 95-percent alcohol (10 minutes), absolute alcohol (5 minutes), and xylol (2 minutes). After this place them on microscope slide in Canada balsam and cover with cover glass.

If the inner parts are important, a bath in 70-percent alcohol between water and 95-percent alcohol may be advisable to avoid distortion. Many prefer to clear the parts in oil of cloves after the 95-percent alcohol and transfer directly to the balsam, thus omitting the absolute alcohol and xylol.

tures can be used for taxonomic purposes. In a later paper (1926) he described the female genitalia of three species of *Epilachna* and figured one. Since then only isolated examples have been recorded and so the structure of the female genitalia of the Epilachninae is still virtually unknown. Dissection of the females of a few species showed soon that the female genitalia in the Epilachninae are extremely useful for the classification of the species and that they supplement admirably the use of the male genitalia. A brief description of the structure of the parts most important for us follows.

The female genitalia consist of the inner part, usually more or less soft, and the outer parts which are well sclerotized. The former consist of the ovaries, oviducts, vagina, bursa copulatrix, and receptaculum seminis. These parts are often in very bad condition in imperfectly preserved specimens, and their real structure cannot easily be ascertained in such specimens. They are therefore of less practical value for the identification of specimens and are left out of consideration in what follows. Figure 189 shows vagina, bursa copulatrix, and receptaculum seminis of *E. deyrollii*. The receptaculum is the most sclerotized of the inner parts and can always be recognized. It is colorless and seems to show little variation in structure. Many species have the same ball-shaped form of the bursa as shown in figure 189. In others it is more elongate.

The outer parts, always heavily sclerotized and therefore easily obtainable in good condition, are modifications of the abdominal segments IX and X. Tergite IX is divided in two parts, each folded double, and envelops the sides of the sternite IX. It has hardly any distinguishing marks. Tergite X, however, varies its shape considerably from species to species. It is an undivided segment, convex or pointed apically in most species of *Epilachna,* but with a truncate apical margin in the *guttatopustulata* group. In *Afissa* the apical margin may be convex, truncate to deeply emarginate, or folded over. It also differs from species to species by the degree of pigmentization. It may be a clear membrane with only the sides dark, or its apical margin may be more or less broadly pigmented.

Sternite IX is divided in half longitudinally and consists therefore of two plates, called *genital plates.* The shape of these is very varied and forms the most useful character for the separation of species. The figures give a better indication of the shapes than a description. Particular attention should be drawn to the inner margin of the plates in *Epilachna.* Near the base there is usually a notch or indentation the shape of which is characteristic for the species and often furnishes a criterion for the separation of closely allied species.

The usefulness of the genitalia for the classification, in contrast to their use as mere aids for identification, is due to the fact that their structure is supposed to have been less subject to external influences than other parts of the body. It is therefore believed a good indication of the natural relationship of the species. A classification based to a large extent on the structure of the genitalia may be considered therefore as being a close approach to the natural classification. In *Epilachna* and *Afissa* changes in the structure of the female genitalia can be very effectively used for the definition of natural groups. The changes in the genitalia are usually accompanied by changes in other parts of the body.

Figures 181-218 are photographs of typical cases. In judging the pictures it must be kept in mind that the relative position of sternite IX and tergite X is not significant, as these two parts are movable with respect to each other.

Secondary sexual characters.—The sexes can be told apart most easily by the structure of the abdomen, particularly the fifth and sixth segments. This has been discussed above. In such species of *Afissa* as *convexa* or *complicata* the differences are striking; in others much closer observation is needed to recognize them. As in most insect groups the female in the average is larger than the male. Often dried specimens are found in which the abdomen is bent strongly up so that the last segments disappear completely from view with the abdomen and elytra in place. Such specimens almost invariably are females, as the male genitalia give the abdomen a greater rigidity that prevents the curling up.

SOURCE OF MATERIAL

The following abbreviations indicate the collections from which the particular specimens were obtained:

AMNH	American Museum of Natural History, New York City.
BBM	Bernice P. Bishop Museum, Honolulu, T. H.
D	Author's collection.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Mass.
NM	United States National Museum, Washington, D. C.
PA	Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.

REMARKS ON THE FIGURES

A representation of the spot patterns of beetles as convex as the majority of the Coccinellidae cannot be made without considerable distortion. The figures accompanying this paper were made either

from camera-lucida drawings or tracings from photographs with the specimen seen from directly above. The distortion near the margin is then quite pronounced, and round spots may appear as very narrow ellipses. However, care was taken to bring out whether a spot actually reaches the margin or not, even if that could not be seen in a view from directly above.

The outline of the pronotum is determined chiefly by its relative inclination to the elytra in the particular specimen. Differences in the outline of the pronotum in the figures do not reflect differences in its actual shape.

The scale to which the figures are drawn is indicated as often as necessary.

The drawings of all male genitalia and of a considerable portion of the spot patterns were made by J. S. Spurbeck, to whom acknowledgment is due for the care which he bestowed on them.

Figures 7-116 represent spot patterns; figures 117-180, 219-226, male genitalia; and figures 181-218, female genitalia.

Genus EPILACHNA Chevrolat

Genotype: *Epilachna borealis* (Fabricius).

The morphological properties of the genus in general have been brought out sufficiently in the preceding section.

Its distribution on all continents centers in the tropical parts, and although some species penetrate into the temperate regions, the representation there is poor. Accordingly, in the Eurasian-Australian region the greatest number of species are found on the southern parts of the Asiatic Continent and the Indomalayan Archipelago. This region is so well isolated from the east, west, and north by oceans, deserts, and mountains that almost all the species occurring there are confined within its limits. Only two species are found in the warmer parts of Europe. One, *chrysomelina,* a species of African origin, has extended its range as far as eastern Siberia but is apparently found only rarely south of the Asiatic mountain barrier. The other species found in Europe (*argus*) is a Mediterranean species of limited distribution. A few of the species have a very wide distribution. *E. sparsa* (Herbst) with its subspecies occurs practically in the whole region where climatic conditions are favorable for its development. Other species have a much more limited distribution, though more material is needed before a clear picture of the geographical distribution of the various species can be obtained. This is necessary also before we know in the majority of cases how

a species is broken up into races or subspecies. The terrain with the many islands and mountain barriers is very favorable for the development of such subspecies, and there are indications that they do occur, but only in the case of *sparsa,* and perhaps on a more limited scale a few others, is the material sufficient for such an analysis to be attempted successfully.

To the northeast the distribution is limited by climatic factors. Only two species reach Japan (*sparsa* and *niponica*), and northern Japan and northern China harbor only one species (*niponica*). The number of species also decreases to the south, probably because most species were unable to cross the water barriers between the chains of islands. The fauna of New Guinea and Australia contains a few ubiquitous species but otherwise is quite distinct from that of the islands farther north. No *Epilachna* has been observed in New Zealand. Two species, *sparsa 26-punctata* Boisduval and *28-punctata* Fabricius, reach as far east over the Pacific Islands as Samoa. However, it is very likely that these species were introduced by man to these islands from the west. This is supported in the case of *28-punctata* by the fact that although it is common in Samoa it seems to be completely absent from the Fiji group and from New Caledonia, and a natural migration from Australia would not have bypassed these islands. No *Epilachna* species has been recorded from Guam or the neighboring groups or on any island east of Samoa.[10]

Epilachna boisduvali, which also occurs on Fiji and Samoa, may have reached there in much earlier times, as the races occurring on Fiji (*fijiensis* Crotch) and Samoa (*samoana,* new) seem to be different from those occurring farther west.

A rational classification of the *Epilachna* species is not easy because of the great uniformity of practically all characters among the majority of species. A subdivision into a few more or less well-defined groups is feasible, but it does not help a great deal for practical identification, because by far the largest number of species belong to one of the groups. The various groups which are subject to revision when more species become known may be identified as follows:

A. *28-punctata group.* Elytra normally each with 6 to 14 spots, which may partly coalesce. Pronotum spotless or with a modification of the normal 7-spotted pattern. Male genitalia with penis an

[10] I am indebted for information on the Pacific distribution of *Epilachna* to Dr. E. C. Zimmermann, of the Bishop Museum, who, with his associates, has made extensive collections in the Pacific islands.

elongate tube more or less curved up near end. Sipho with a bend of less than 90° near base. Female genitalia with tergite X apically convex or pointed. Species Nos. 1-32.

B. *Miscellaneous.* Species that do not fit into any of the other groups are lumped together here. Each probably should be regarded as a separate group. (The position of some of these species is doubtful, as only one sex is known, and the separation from the preceding group is not quite clear.) Species Nos. 33-41.

C. *Ennaesticta group.* Elytra each with six spots, pronotum as in A. Male genitalia with penis broad and short, sipho greatly deformed. Species Nos. 42-44.

D. *Guttatopustulata group.* Species with a dark ground color. Tergite X of female truncate or broadly convex. Species Nos. 45-48.

The groups B-D present no difficulties for the separation of their species. The *28-punctata* group, however, contains a large number of closely allied species, many of them so similar to one another that even with the help of the genitalia a proper limitation of the species is not always easy. A definite recognition of the species from the original description is often impossible. The name labels attached to them in some of the collections I have seen looked as if they had been distributed at random. Very likely the synonymy of many species will have to be revised ultimately with the help of the types. References to species in this group in the literature must always be regarded with caution, as a great deal of confusion has existed. The spot pattern of pronotum and elytra of this group is very variable within one species, often much more so than the systematic differences between different species. The variations follow always a definite pattern that may be characteristic for the species. For an understanding of the interrelations of the various species a discussion of the spot pattern is very essential. The species of group C and some of group B follow the same elytral pattern, but the pronotum is usually spotless.

The spot pattern both of pronotum and of the elytra of groups A and C can be regarded as derived from the same basic pattern. This may be true also for the other groups, but the connection there is not so obvious.

Pronotum.—The basic pronotal pattern is that of fig. 4 E with seven separate spots which will be numbered throughout the paper as indicated in the figure. This pattern may be modified either by a decrease in the black pigment or by an increase. In the former case (fig. 4 A-D) some of the spots are missing or are smaller or

less black, and in the extreme case, which is rather common, the pronotum is entirely spotless. When there is an excess of pigment (fig. 4 G-L) the spots are enlarged and flow together, and in the extreme case the pronotum is entirely black with only a narrow light margin at the front and sides. Various other combinations and intermediate forms not shown in the figures also occur.

All observed spot patterns of the species of group A belong clearly in this category. The individual range of variation within one species may be considerable, as for instance in *28-punctata* (observed

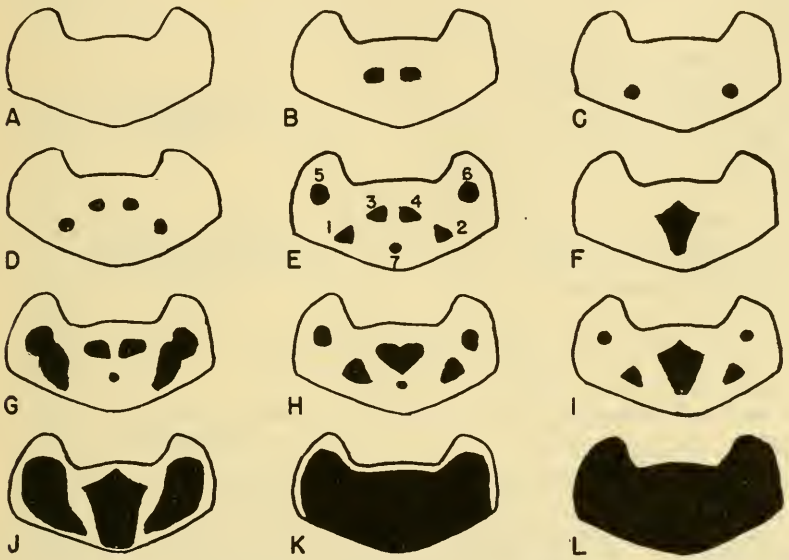


FIG. 4.—Maculation of pronotum of *Epilachna* species.

extremes, fig. 4 A-I) or *niponica* (fig. 4 H to K). However, the specimens from a given locality seem to show much less variation. Care is therefore needed in evaluating the significance of the pronotal spot pattern in the descriptions. It is quite possible that specimens of the same species obtained from localities different from those used for the descriptions may show variations either in the direction of more or less pigment. In a few species (*libera, signatipennis*) the spots have a tendency to become very hazy. *E. boisduvali* seems to have a spot pattern that does not fit into the scheme of figure 4.

Elytra.—The fundamental elytral spot pattern consists of six dark spots on each elytron arranged as indicated in plate 1, figure 8. The exact position, shape, and size of the spots varies considerably,

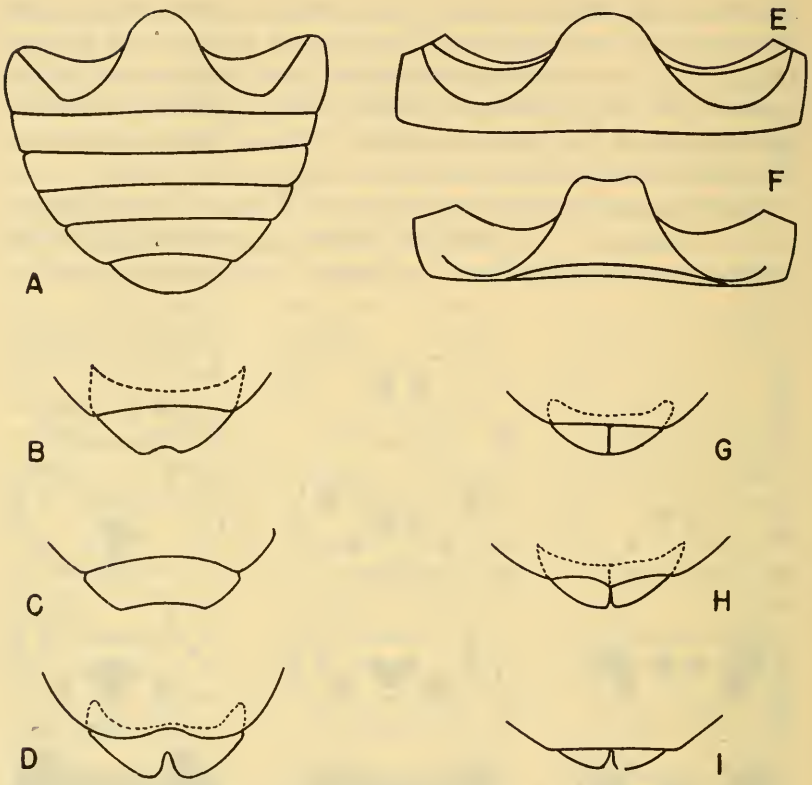


FIG. 5.—Structure of abdomen in *Epilachna* and *Afissa*.

A, abdominal lines complete, subterminal, sixth segment ♂ convex (*E. dentulata*); B, ♂ sixth segment emarginate (*E. diffinis*); C, concave (*E. indistincta*); D, notched (*E. guttatopustulata*); E, abdominal lines rounded, complete (*E. chrysomelina*); F, terminal, incomplete (*Afissa chapini*); G-I, sixth segment of ♀ of *Epilachna* species (G, *28-punctata;* H, *chrysomelina;* I, *pytho*).

FIG. 6.—Sixth abdominal segment of female.

A, *Afissa alternans;* B, *A. grayi.*

but none of these spots is ever absent except in rare exceptional cases. They are called therefore *persistent* spots and numbered[11] 1 to 6 as indicated in figure 7.

This fundamental spot pattern may be modified by the addition of one to eight extra spots on each elytron, or by the enlargement and confluence of several spots. In either case the modification proceeds according to definite rules.

The additional spots are called *nonpersistent* spots because their presence, even in the same species, is very variable. If the full number of spots, 14 on each elytron, is reached, we have again a very stable form of very characteristic appearance (figs. 7, 12, 19, 21-23, etc.). The nonpersistent spots are identified by the letters *a* to *h* as indicated in figure 7. Since their position varies only slightly, there is in general no trouble in identifying these spots even if only a few are present. Their size and pigmentation, however, are very variable. In some cases they are much smaller than the persistent spots (fig. 9) or they are definitely less dark. In other cases they have substantially the same size and development as the persistent spots (figs. 21, 22). There are species that so far as known are always 12-spotted, i.e., without nonpersistent spots (*boisduvali, argus, diffinis,* etc.), and others like *28-punctata* which always or nearly always carry the full number 28, but in general the number and development of the nonpersistent spots may vary within one species between the two extremes. The development of the nonpersistent spots can therefore never be regarded as a specific character. Often the variations may be extreme if specimens of the whole range of the species are considered, but individuals from one locality are more or less constant (e.g., *sparsa 26-punctata* on the Pacific islands). Then the species is broken up into a number of subspecies which differ by the development of the spot pattern. These subspecies may merge gradually one into another, as seems the case for *sparsa,* or they may be quite distinct without transitional forms. A few cases are known where only the 12-spotted and the 28-spotted forms exist, without any intermediates.

Whether in the evolution of the genus the development proceeded from the 12-spotted to the 28-spotted form or vice-versa can at present only be speculated upon. The material suggests strongly another possibility—that there were originally two geographically

[11] This manner of numbering is that adopted throughout by Mulsant and followed by Weise, at least in his later papers. Other authors have used different ways of numbering the spots.

separated species, one with 12, the other with 28 spots, which gradually intermingled and produced the variety of forms by cross-breeding, followed possibly by further evolution.

The second way in which the spot pattern is modified in *Epilachna* is by the enlargement and confluence of spots. The extent to which this occurs is again very variable within one species, but the tendency for a certain form of variation may be characteristic for the species. The most frequent variation is probably a lateral enlargement of spots 3 and 4 until they coalesce. This is occasionally observed in *sparsa* on the Indonesian islands (fig. 17). If No. 3 is also joined to No. 5 we have the typical spot pattern of *signatipennis* Boisduval (figs. 18, 50). Spots 1 and 2 may also coalesce as in *libera* (figs. 59 and 60). *E. libera* shows a few of the nonpersistent spots, which usually seem to be absent in those species showing great tendencies to coalescence. When this process of coalescence is completed we have a pattern like that of *solomonensis* (fig. 61), consisting of two transverse fasciae, the basal one due to the coalescence of spots 1 and 2, the discal one of 4, 3, and 5, and in addition spot 6. In *solomonensis,* for instance, the origin of the completed pattern as a modification of the fundamental 12-spotted pattern is little apparent, but in other species all the intermediates occur. This type of pattern with two fasciae is recognizable by the fact that the discal fascia is bent back near the suture so that a V is formed there. The pattern of *parafasciata* (fig. 62) has also two fasciae with an apical spot, but the discal fascia does not show this V-like bend. The exact relation of this with the 12-spotted pattern is not quite clear. Possibly spot No. 5 moved forward on the suture.

Another type of coalescence is illustrated by figures 39 and 40, in which the spots are still separate but show the tendency of variation, and figure 41, where the coalescence is complete. Spot 2 is still quite unaffected. If this is also enlarged along the margin and toward No. 3 we get a pattern like that of *delesserti* (fig. 58), which appears as five light spots on each elytron on a dark background.

Whether a pattern like that of *haemorrhoa* (figs. 63, 64) is directly related to the 12-spotted pattern is problematical, although in light specimens it is resolved into several dark spots on a light background. The similarity of the genitalia of *haemorrhoa* and species of group A makes this probable. Even more uncertain is the relation of the pattern of the species of the other groups to the 12-spotted ground form even though the form *tricincta* of *guttatopustulata* (fig. 72) is very similar in appearance to *solomonensis* or *parafasciata.*

There is a third type of modification found frequently among the coccinellids but rarely among the Oriental species of *Epilachna.* This is the darkening of the general background of the elytra, often with a lighter ring around each spot. Such ocellate forms are common with *chrysomelina,* particularly among the African races. It occurs in *ocellata* apparently as the ground form (fig. 38). On the Fiji Islands such a darkening of part of the elytra occurs without the light rings, so that in the extreme form part of the elytra is completely black (fig. 16). This form apparently occurs, however, only as an aberration.

Because of the great similarity between many of the species, a key in the usual form would be of little help. A study of the figures will make a quick orientation possible, and a comparison with the individual descriptions will be necessary for the exact identification. All the descriptions should be used together with the figures, because for those characters (like spot pattern, shape, etc.) expressed in the figures, the descriptions are meant chiefly to call attention to the most important facts and are not to be regarded as an alternate to the figures.

1. EPILACHNA SPARSA (Herbst)

FIGURES 8-18, 117, 181

Coccinella sparsa HERBST, 1786, p. 160.

Abdomen.—Abdominal plates subcomplete, reaching to within one-fifth of the apical margin of the first segment. Fifth segment, male, apical margin truncate or slightly concave; female, truncate. Sixth segment, male, distinctly [12] emarginate; female, split.

Male genitalia (fig. 117).—Penis seen in profile, under side with a bulge beyond the middle followed by an emargination, after which the penis curves up into an apical hook; upper side with a wide, bladelike vertical ridge beginning at the foot of the paramera (basal knife edge). Second half with two rows of hairs, 0.1 to 0.2 mm. long. Seen from below, closed tube with seam along the middle, orifice elongately diamond-shaped; penis immediately after the orifice less than half the width it had before the orifice, and then almost with parallel sides until it curves up. Paramera about 1.3 mm. long with apical thorn and covered with hairs slightly shorter than those on

[12] There are some specimens from Java that have the apical margin of the male sixth abdominal segment ertire, without an emargination. These specimens cannot be distinguished in any other way from those showing the emargination.

penis on the last 0.2 mm. of its length. Sipho gently curved near the base, from then on nearly straight, ending in a point. The orifice oval, on the outside just before the point.

Female genitalia.—Plates (fig. 181) on the inner margin about one-fourth distance from base, an excavation on the under side with a sharp dark edge toward apex. By the shape of this excavation the female specimens of *sparsa* can be distinguished from neighboring species.

Length.—6 to 7.5 mm.

Apical angle of elytra usually distinct; mandibles with trilobed apical and two lateral teeth and many dentules.

Color and maculation.—Varying between wide limits, both among the specimens found at one locality and between the various geographical races, to be described in detail below. The under side may vary from completely light yellowish red, including legs and appendages of head, to dark brown to black on metasternum and large part of abdomen. The ground color of the upper side is red. The pronotum varies in maculation from the spotless form to the form with all spots well developed and beginning to coalesce (fig. 4 A-E, H). Forms with the pronotum largely black, due to the confluence of the spots such as occur in *E. niponica, 28-punctata,* and similar species, have not been observed. The elytra varies between the form with 6 spots on each elytron and the other extreme with all 14 spots present. Rarely is one of the persistent spots missing, but practically any number of spots between 6 and 14 may be expected with greatly varying sizes of the individual spots. In some instances the confluence of several spots takes place (figs. 17, 18). The most common forms and the range of variability are very different in the various localities where the species is found, and details will be given below.

Type locality.—East Indies.

Distribution.—More than 500 specimens from a wide range of localities permit a fairly clear idea of the distribution. On the Asiatic Continent it ranges from India to North China, with the exact western limits unknown. Its limitation to the north and east is probably determined by the fact that it needs an average yearly temperature of 15°C. or more for its development. It occurs also in southern and central Japan. In the Indian Archipelago it is known from Sumatra, Java, Lombok, and Amboina, and probably is found on many other islands. In the subspecies *26-punctata,* it occurs on New Guinea and Australia and extends to the Fiji and Samoa Islands, where it reaches its eastern limit. It is not known from the

Philippines and probably is replaced there by *E. philippinensis,* which may be a subspecies of *sparsa.* Because of its confusion with other species, all reports in the literature on this and related species must be regarded as unreliable.

Epilachna sparsa (Herbst) has been regarded by all authors as a synonym or variety of *E. 28-punctata* (Fabricius). What Fabricius had before him when he described *Coccinella 28-punctata* cannot be ascertained now without the type, which apparently has not been preserved. Weise and others identified *E. 28-punctata* with a species that is obviously different from *Epilachna sparsa* (Herbst). Accordingly, the latter becomes a valid name. The figure that accompanies Herbst's meager description (fig. 11) gives much more information of the species than the description itself. It shows that the spots are of very unequal size and that spots *a* and *f* are missing. Specimens like this are very common in India, whereas what is usually known as *E. 28-punctata* never shows this kind of spot pattern. What is called *E. 28-punctata* in the literature may refer to the true *28-punctata* but probably more often to *E. sparsa* and sometimes to several other related species. (See also the comments under *E. 28-punctata.*) *E. sparsa* also goes under the name *E. 28-maculata* Motschulsky, which, however, is very probably a name belonging to a different species, *E. niponica.* (See also comments under that species.)

Epilachna sparsa is very variable in appearance, and this variation has resulted in the description of some of its forms under separate names. *E. gradaria* Mulsant, with its varieties *addita, vieta, socors, congressa,* and *stolida,* and *E. territa* Mulsant are probably only forms of *E. sparsa.* It is quite likely that several other Mulsant species will fall in the same category, although the descriptions are not definite enough to settle this. In collections I have seen *E. sparsa* under the names *taeniata* Mulsant, *dodecastigma* Mulsant,[13] *pusillanima* Mulsant, *indica* Mulsant, and others.

The status of these different forms is of great interest. Of course, we may be dealing here with a number of closely related but distinct species. However, this does not seem very likely. There is no definite structural character by which such species might be separated. The genitalia are alike, though not completely identical in all forms. The differences in the genitalia that are found, such as the width of

[13] *E. dodecastigma* (usually misspelled *dodecostigma*) is credited in the literature, including the Korschefsky Catalog, to Mulsant. However, the species was described by Wiedemann (1823). Mulsant (1850, p. 789) omitted the reference to Wiedemann's description, which omission he later corrected (1853, p. 248).

the bladelike ridge on the upper side of the base of the penis or the exact shape of the profile of the penis, seem to vary gradually and are not correlated with features in the external appearance. To take coloration and spot pattern as a basis for separation into species as has been done in the past leads immediately to difficulties, since almost all intermediates occur.

The other alternative—that we are dealing with one variable species that is broken up into a number of geographical races or subspecies—seems much more likely to represent the real state of affairs and is in agreement with the known facts, although much more material is needed, preferably supplemented by biological observations and breeding experiments, before we have anything like a complete picture. Some of these subspecies are sharply defined; others partly overlap and can be defined only statistically.

The separation of *Epilachna sparsa* from species with similar appearance can best be made by the male genitalia and often also by the female genitalia. Details are given under the various species. In many cases the separation may be carried out from external characters alone. Usually this can be done readily, but great care must be taken, as many of these characters are so variable that they need checking with the genitalia.

After a brief characterization of the principal subspecies outstanding enough to deserve separate names, a list of the localities of the specimens seen by me is presented with a characterization of subspecies in those localities. It hardly needs emphasis that when such a characterization is based only on a few specimens it must be considered as only tentative.

EPILACHNA SPARSA subsp. SPARSA (Herbst)

Epilachna sparsa var. *gradaria* Mulsant 1850, is the extreme form, with the following variations which have the nonpersistent spots indicated:

addita Mulsant	b, h
vieta Mulsant	f
socors Mulsant	b, c, d, h
congressa Mulsant	g

Epilachna gradaria Mulsant seems to be the form of *sparsa* occurring in India, with only the 12 persistent spots present, which are arranged as in figure 8. No. 1 is well below the scutellum and No. 4 is separated from the margin. The Mulsant varieties, according to the original descriptions, have, in addition to the 12 persistent spots,

the nonpersistent spots indicated by the letters in the listing above. Two others occurring frequently are figured in figures 9 and 10. Spots 1 and 2 are usually much smaller than the other persistent spots, which is also true in Herbst's original drawing. The varietal names of Mulsant should not be continued, as the differences are insignificant and there would be a great number of others having similar spot combinations which would have equal rights for separate names.

Those specimens with the full number 28 of spots or one or two missing should be regarded as the nominal form of *sparsa*. *E. sparsa sparsa* and *sparsa* var. *gradaria* are therefore only two extreme forms of the same subspecies with all the intermediates occurring.

Material examined.—164 specimens. India: Southern India, Coimbatore, February 10, 19, 22, June, September 7, November 6, 7, 10, 12, December 1, 1945; Malabar, Walayar Forest, 700 feet, November 15, 1945 (P. S. Nathan, D); Punjab, Jullundur; Punjab and United Prov., June-October (R. L. Woglum, NM); United Prov., Dehra Dun, July 10, 1944 (J. Unyal, D); Assam, Shillong, July 1945 (J. Unyal, D); Chabua, Doom Dooma, April 8, 28, 1945, 10 miles north of Tinsukia, March 29, 1944 (D. E. Hardy, NM); Bengal, Barackpore, April 1, 1944 (D. E. Hardy, NM); Mangalore (J. C. Bridwell, NM). Northern India, Kooloo and Ambala (Carleton, MCZ).

Remarks.—*Epilachna sparsa* in India shows a great deal of variation. The pronotum varies from spotless to all seven spots well developed, with all intermediates. The elytral spot pattern may have only 12 persistent spots or the full number 28 with all intermediates occurring. Sometimes the persistent and nonpersistent spots are equally well developed, in other cases the nonpersistent spots are definitely smaller. Almost any number of nonpersistent spots can be found present, from one on each elytron to the full number eight with practically any combination. Spot *a* seems to be the one most easily disappearing and usually *d* is the last one to go.

There is not sufficient material to decide whether there are any systematic variations with locality. The specimens from Punjab are smaller than those from either farther south or north and have lighter coloration with very few specimens having the full number of spots. The specimens from northern India (Kooloo and Ambala) approach subspecies *orientalis* by having spots *ab3d* approximately in one line.

EPILACHNA SPARSA subsp. ORIENTALIS, new subspecies

FIGURE 12

This subspecies, which occurs in China and Japan, has the full number, 28, of elytral spots. Spot 1 is with its most forward part back of the tip of the scutellum, and No. 4 is usually free from the margin. In this respect it differs from the insular races and approaches *sparsa sparsa.* The spots are usually fully developed, but the persistent spots are most often considerably bigger than the non-persistent ones. There is great diversity in size. Spots *cb3d* lie approximately in line. This latter fact immediately allows a separation from *E. niponica* Lewis and *E. dentulata,* two different species with which it overlaps partly in distribution. This subspecies is usually called in the literature *E. 28-maculata* Motschulsky, and often *28-punctata* Fabricius. It seems quite certain that Motschulsky's *28-maculata* refers to a different species (see under *niponica* Lewis). The new name *sparsa orientalis* is selected for it. Pronotum usually with seven distinct spots, of which No. 7 or Nos. 5 to 7 may be missing. Under side light, with sides of metasternum usually black. The dark color may be spread to most of the abdomen, the sides of which, however, always seem to stay lighter.

Material examined.—There are more than 70 specimens from China and Japan.

Type: U.S.N.M. No. 57106, from China, Fukien Prov., Fuchow-Ming Chiang, June 1926 (F. P. Metcalf).

Paratypes: 8 specimens. Same data as type. China: Kiang-su Prov., Shanghai, August 29, 1919 (H. F. Loomis, 1 specimen); Nanking, August 14, 1919 (H. F. Loomis, 5 specimens); Soochow (C. F. Wu, 2 specimens); Chingkiang, July 19, 1924 (J. F. Illingworth, 2 specimens, BBM); Shensi Prov., Ching-ling Mountains, May-June 1904 (E. Blackwelder, 1 specimen); Szechwan Prov., Kuifu, October 1930, November 5, 1930 (2 specimens); Hunnan border, south of Suifu, June 10, 1929 (D. C. Graham, 1 specimen); between Chentu and Kuanhsien, July 2-5, 1924 (D. C. Graham, 1 specimen); Anhwei Prov., Taipingshien, October 1932; Kiuhua Shan, September 1932 (G. Liu, MCZ, 23 specimens); A. Koebele, 1 specimen (no further data); Hong Kong (1 specimen, BBM); Yen-Ping (1 specimen). Japan: Gifu Pref., Mitsukuri (5 specimens); Kobe (C. F. Baker, 1 specimen); Kiushu (1 specimen).

For additional records, see under biology.

EPILACHNA SPARSA var. CINEREA, new variety

This variety is distinguished from the common form of *sparsa orientalis* by the pubescence of all the elytra being gray, including the black spots. No other significant differences were noted. It overlaps in distribution with *sparsa orientalis,* and so it must be regarded as a variety of the latter with more localized distribution.

Maculation.—Thorax usually as in figure 4 E, spots 3 and 4 often united.

Elytra.—All 28 spots present and usually separate. Occasionally spot 1 touches the suture, and often spots *h* and *g* are coalescent.

Material examined.—32 specimens (NM, D).

Type: U.S.N.M. No. 57107, from China, Szechwan, near Kuanhsien, alt. 2,000-4,000 feet, August 1933 (D. C. Graham).

Paratypes: 24, from the following localities, all China, Szechwan Prov. (D. C. Graham): Ningyuenfu, alt. 6,000-6,200 feet, July 31-August 5, 1928, and Kuanhsien, alt. 2,000-3,000 feet (14 specimens); Suifu, alt. 1,200 feet, September 25, 1923, June 6, 1929. Also China, Kiang-su Prov., Nanking, August 1919 (H. F. Loomis).

Additional specimens: China: Kiang-su Prov., Shanghai, August 29, 1919 (H. F. Loomis); Fukien Prov., Foochow, September 29, 1914 (C. R. Kellogg); between Yachow and Tatsienlu, alt. 2,200-8,000 feet, July 7-14, 1930 (D. C. Graham, A. Koebele). India: Assam, Shillong, July 1945 (J. Unyal, D).

Remarks.—There are some specimens of *E. sparsa sparsa* in which the gray pubescence of the red parts of the elytra partly transgresses on the black spots. They are intermediate between the regular forms and the variety *cinerea.*

EPILACHNA SPARSA subsp. TERRITA Mulsant

E[pilachna] territa MULSANT, 1850, p. 787.

What Mulsant described as *E. territa* appears to be the 12-spotted form of the subspecies of *sparsa* prevalent in Java. It differs from *gradaria* by its larger size, more elongate form, and the fact that spot 1 is farther advanced, so that a line tangent to the basal margins of these spots goes approximately through the apex of the scutellum. Spot 4 is widened transversely and is joined to the margin. Pronotum usually spotless, occasionally with up to all seven spots present though only faintly developed.

Figures 13 and 14 show forms with some nonpersistent spots present. Many other combinations occur, but usually the nonpersistent spots are much smaller than the persistent ones. The fully

developed form with all 28 spots has not been found. Spot *a* is usually absent. There were only two specimens with spot *a* present, both of which, however, had some other spot absent. The more fully developed specimens with only spot *a* absent approach very closely subspecies *26-punctata* Boisduval. There are in Java, however, also specimens occurring simultaneously with *sparsa territa* that have the shape of *sparsa sparsa* but the maculation of *sparsa territa,* and there are others that are both in shape and maculation like *sparsa sparsa.*

Type locality.—Java.

Material examined.—65 specimens. Buitenzorg, April-December 1896 (D. G. Fairchild, NM); March-April 1909 (Bryant and Palmer, NM); Tjibodas, Mount Gede, April 1909 (Bryant and Palmer, NM).

EPILACHNA SPARSA subsp. 26-PUNCTATA (Boisduval)

C[occinella] vigintisexpunctata Boisduval, 1835, p. 590.

The specimens from Australia and the Pacific Islands agree very well with the detailed description of *E. 26-punctata* given by Mulsant (1850, p, 838). The localities (Australia, New Guinea, Java), which Mulsant quotes for *26-punctata,* agree, so that there is little doubt that these specimens do represent *E. 26-punctata* (Boisduval). (The Java specimens are here referred to subspecies *territa.*) This subspecies is very constant in appearance and very well characterized. Spot *a* is invariably missing, but all the other spots present except in rare exceptions. Spots 1 and 4 situated as in *territa* Mulsant. A line touching the basal margins of spot 1 goes approximately through the apex of the scutellum, spot 4 widened and joined to the margin. Pronotum most often with four spots (1 to 4), the middle ones frequently united or almost united. Occasionally only two spots (1 and 2) and often six or all seven. All the elytral spots are about equally well developed. The under side is light except the sides of the metasternum which are black. Often the dark color spreads to the middle of the basal abdominal segments.

Material examined.—More than 260 specimens from the following localities:

Australia: Queensland, Babinda (J. F. Illingworth, NM, BBM); New South Wales (Edwards coll., AMNH), 5 specimens; Victoria (Koebele, NM; Edwards coll., AMNH), 1 specimen.

Fiji Islands, more than 250 specimens (mostly BBM): Vitilevu Island, Suva Bay, Hsivithule-Tailevu, Korovou-Tailevu, July 16,

1923, August 3, 16, 1937 (O. H. Swezey, G. R. Wilder, J. M. Valentine, BBM); Suva Bay, December 1915 (J. C. Bridwell, NM); Ways Island, Yasawa group, July 15-19, 1937 (H. St. John, BBM); Kadavu Island, Ndavingiele, April, 27-30, 1941 (N. L. H. Krauss); Moala Island, July 13, 1924 (E. H. Bryan, Jr., BBM); Totoya Island, July 15, 1924 (E. H. Bryan, Jr., BBM); Matuku Island, July 4, 1924 (E. H. Bryan, Jr., BBM); Lau Island, August 5, 31, September, 1924 (E. H. Bryan, Jr., BBM); Ovalau Island, Thawathi, 600-800 feet, July 16, 1938 (E. C. Zimmermann, BBM).

Samoa Islands: Savaii Island, below 1,000 feet, April 30, 1924 (E. H. Bryan, Jr., BBM); Upolu Island, Afiamalu, Apia, June 4-14, 1940, 1,300 feet on pumpkin, 2,200 feet on *Solanum nigrum* (O. H. Swezey, BBM); Tutuila Island, February, March, and September 5, 1923, December 18, April 8 (E.H. Bryan, Jr., D. T. Fullaway, H. C. Kellers, BBM); Ofu, Manua group, February 27, 1926 (A.F. Judd, BBM). This is the easternmost locality from which any specimen of *E. sparsa* or any other Oriental species has been recorded.

Epilachna sparsa var. nigrescens, new variety

Figure 16

Among the Fiji material are a few specimens of a very peculiar color aberration. The larger part of the elytra is solidly black. This black part extends from the line formed by spots *bc3d* to the apex, so that only spots 1 and 2 are free and surrounded by the yellow background. In the apical black part only a few traces along the suture are left light. The color of pronotum and the under side is normal. Two females show this extreme, while two males show the black color less perfectly spread out so that the original black spots in the apical part still can be recognized.

Type.—Bernice P. Bishop Museum, Honolulu, from Fiji.

Synopsis of geographical distribution and variation of E. sparsa

India: See under *sparsa sparsa.* A female from Ceylon differs so much in the genital plates that it probably belongs to a different species.

Sumatra (24 specimens): Brastagi, May 1927 (F. J. Meggitt, NM); Siantar, 1937 (Mann, NGS-SI Exp., NM); R. Weber, (AMNH); Deli, 1912 (De Bussy, NM); Tandjong Poera (NM); East Sumatra, 1917 (Knab, NM).

All specimens with spotless pronotum and 6-spotted elytra, except

two which have a few of the nonpersistent spots faintly indicated. In some of the Sumatra specimens the persistent spots are very unequal in size, e.g., 1-4 normal, 5 and 6 very small, practically absent. One specimen, Parpat, (coll. Mann, 1937, NM) has spots 4+3+5 united.

Siam: Mekami River, February 3, 1928 (A. Mackie, NM) 12-spotted form.

Indochina: Tonkin, Thai Ha, June (MNH), like *orientalis* (3 specimens); with spot *a* missing (2 specimens); with spots 1 and 4 on pronotum (1 specimen); Cochin China, Bienhoa Prov., Trang Bom Arboretum, 30 miles northwest of Saigon, July 18, 1932 (M. Poilane, NM, 2 specimens); Annam, Hue (NM), 12-spotted, 3+4 united.

Indochina (NM), 26-spotted. The Indochina specimens seem to form the transition between the subspecies *sparsa* and *orientalis.*

Malay: Larat, December 1907, 3 specimens (BBM), with 26 spots (*a* missing), spots small, *cb3d* not on straight line, pronotum with spots 1-4.

China and Japan: See under *sparsa orientalis.*

Java: See under *sparsa territa* Mulsant.

Lombok: Sapit, 7 specimens (NM), very much like *26-punctata* (Boisduval); pronotum usually spotless.

Amboina: 3 specimens (Buitenbos, NM), 12-spotted with large spots. As all the specimens are females, the identification is not quite certain.

Batjan Island (between Celebes and New Guinea, lat. 1°S., long. 127.5°E.): 1 specimen (NM), 12-spotted with rather large spots; pronotum spotless.

Australia, New Guinea, Pacific islands: See *sparsa 26-punctata* (Boisduval).

Borneo: Sandakan, 1 specimen (Baker, NM), 12-spotted with rather small spots.

BIOLOGY

The biology of *Epilachna sparsa* furnishes a typical example for the biology of similar species that apparently do not differ very much in this respect. It has been studied in more or less detail by several investigators in various countries, but was reported usually under the name *28-punctata* (Fabricius). A report in which there can be no doubt about the identification of the species is that by Takahashi (1932), who made extensive studies on *E. sparsa orientalis* in Japan. Some of his results are as follows:

Climatic preferences: In Japan *E. sparsa* lives in the warmer parts and finds its distribution limit roughly where the mean annual temperature is 15°C. (69°F.), the mean maximum 19°C. (76°F.), and the mean minimum 9°C. (48°F.). Where it is colder the species cannot develop. This brings the northern limit in Japan to just above latitude 36° (north of Tokyo), higher in protected places, much lower in the mountains.

E. sparsa has two generations in most of Japan, three in the south. It hibernates as adult beginning in October and emerges the end of April or beginning of May.

It lays eggs in clusters on the under side of leaves, total number of eggs laid per female (in laboratory) 192 to 2,272, average 1,161. The larva emerges after 3 to 8 days and spends 14 to 26 days (four instars) until pupation. Pupal period 3 to 5 days. Total period from egg to emergence of adult 20 to 46 days. The higher the temperature, the shorter the development period. Adults developing from the spring generations are on the average larger than those of the fall generation. This is attributed to the greater moisture content of the food plants during spring.

The food plants both for adults and larva are, in the order of preference:

Physalis alkekengi L.
Solanum nigrum L.
Solanum tuberosum L. (potato).
Solanum melongena esculentum Nees (eggplant).
Solanum ovigerum Dan.
Lycopersicum esculentum Mill. (tomato).
Datura alba Nees.
Cucumis sativus L. (cucumber).
Actinostemma lobatum racemosum Mak.

In Japan the chief damage is to potatoes and eggplants. The adult causes more injury than the larva. This contradicts the observations of other workers and may be due to too few cases. For control, arsenate of lead is recommended besides a cover crop of ground cherries (*Physalis*) on which the beetles gather gregariously in spring and can be destroyed.

Reports from more tropical countries differ from the above report chiefly by the shorter development period, e.g., for Kwantung Prov., China (Chue, 1928), the development period from egg to adult averaged 16.4 days, with a mean temperature of 28.6°C., and there are 5 or 6 generations a year. Here the chief damage is done to eggplants, and cucurbitaceous plants are not attacked in the field when other food is available.

Figures and descriptions of egg, larva, and pupa will be found in Takahashi's paper (1932).

2. EPILACHNA PHILIPPINENSIS, new species

FIGURES 19, 118

General habitus like *sparsa*.

Abdomen.—Abdominal lines subterminal and complete, outside margin straight. Fifth segment, male, hind margin slightly concave; female truncate. Sixth segment, male, hind margin slightly emarginate; female, segment split lengthwise.

Male genitalia.—Penis seen in profile, distinctly bent upward at about three-fourths of its length so that both the upper and lower margin show this upward bend. Thickness slightly increases just after the bend and then decreases; ends in apical hook. Two short rows of hairs 0.1 to 0.2 mm. long on upper side after bend, occasionally a few hairs also on the basal end. Paramera, with apical thorn, length about 1.5 mm.; sipho ends in sharp point as in *sparsa*.

Female genitalia.—Plates, length 0.53 mm., greatest width 0.33 mm. Differ from those of *sparsa* only in having the notch on the inner edge less deep.

Length.—5.6 to 7.2 mm. Tips of elytra with distinct angle.

Maculation.—Pronotum usually immaculate, occasionally spots 1 and 2 present and traces of others; elytra usually with the full number 28 of spots, spot *a* usually small and often missing. Occasionally others of the nonpersistent spots missing or very small. Spots *cb3d* do not form approximately a straight line. The arrangement of spots is very much as shown in figure 19, but spot *d* is most often an elongate rectangle. In a few specimens spots 3 and 4 flow together.

Material examined.—Type: U.S.N.M. No. 57108, from Philippine Islands, Luzón, Nueva Vizcaya Prov., Imugan (R. C. McGregor).

55 paratypes and 22 other specimens in U. S. National Museum, all from Luzón, from the following localities: Nueva Vizcaya Prov., Balite Pass, Imugan; Laguna Prov., Bay; Bataan Prov., Limay, November 8, 1924; Ilocos Norte Prov., Bangui, Solsona, December 1923; Ilocos Sur Prov.; Nueva Écija Prov. (all R. C. McGregor). Also from Luzón: Mount Maquíling, Los Baños, January 10, 1910, and Mount Banájao (all Baker); Lanao (C. V. Piper). From Manila: 1909 (G. Compere, W. A. Stanton), 1911 (C. V. Piper).

Remarks.—This species is very close to *sparsa* and might possibly be considered a subspecies of it that has developed so far away from

the main species as to form a distinct species now. It differs from *sparsa* by the upward bend of the male penis, by which the two species can always be distinguished. The maculation of *philippinensis* is very much like that of *sparsa.* The usual form has the full number 28 of elytral spots. However, *cb3d* do not lie on a straight line as in *sparsa orientalis.* The nonpersistent spots are often weaker than the persistent ones, or partly or completely absent. In the latter case we have the subspecies *remota.* There are a few specimens where spots 3 and 4 are confluent as in figure 17. The nonpersistent spots are, however, also partly or completely present in these cases. For the relations to *doryca* Boisduval, see the note to that species.

The fully spotted form of *philippinensis* seems to be confined to Luzón. *E. sparsa* has not been found at all in the Philippine Islands, and so it is probably safe to decide between the two species in cases of doubt from the locality alone without dissection of the genitalia, which otherwise is the only safe criterion. *E. philippinensis* is very similar in external appearance to *E. dentulata,* which also occurs on Luzón. Either the male or female genitalia permit an unambiguous separation of these two species. With a little care they can also be distinguished by their external appearance. *E. dentulata* is more rounded and convex and has the tips of the elytra definitely rounded. Spot 4 reaches the side margin in *dentulata* except in some very lightly colored specimens from Indochina, whereas in *philippinensis* it never seems to touch the margin.

EPILACHNA PHILIPPINENSIS subsp. REMOTA, new subspecies

FIGURE 20

This subspecies is identical with *philippinensis* s. str. in the male and female genitalia and in all morphological characters. It differs by the absence of all the nonpersistent spots on the elytra and so there are only six spots on each elytron. It seems to occur on the outlying islands rather than on Luzón. Some of the few specimens known from Luzón have a few of the nonpersistent spots present, and form thus transitions between this and the typical subspecies.

Material examined.—26 specimens (all NM).

Type: U.S.N.M. No. 57109, from Philippine Islands, Mindanao, Dávao Prov., Mati, June 1927 (R. C. McGregor).

13 paratypes and 12 other specimens: From same locality as type, March and June 1927 (2 specimens). Negros Island (8 specimens): Victorias, 1927 (W. D. Pierce); Cuernos Mountains (Baker); May 1911 (C. V. Piper). Others from: Mindanao, May 1911 (C. V.

Piper); Manila, 1911 (C. V. Piper); Cádiz, on *Datura alba;* Palawan Island, Puerto Princesa (Baker); Sulu Islands, Jolo, July 24 (A. Duyag, McGregor); Bohol Island, Bilar, September 1923 (McGregor); Luzón, Los Baños (Baker); Luzón, Nueva Vizcaya Prov., Balite Pass (McGregor).

One specimen from New Guinea (G. Compere) has spots 3 and 4 confluent.

EPILACHNA PHILIPPINENSIS subsp. AUSTRALICA, new subspecies

Specimens from Australia are known which, though they resemble in maculation dark specimens of *E. 28-punctata* much more than the typical *E. philippinensis,* have genitalia that cannot be distinguished from those of *E. philippinensis.* They are therefore tentatively identified as a subspecies of *philippinensis,* but more material is needed before any definite conclusion can be reached as to relation between *philippinensis australica, sparsa 26-punctata,* and *28-punctata,* which all occur in Australia and are so similar in appearance that they have been confused completely in the previous literature.

The maculation is very similar to that of figure 22, but spots *d* and *g* are actually on the suture. The pronotum has a black disk not resolved into spots with a narrow margin at apex and base and a wider one at the sides light in all but one of the specimens. In this one, which is lighter all around, pronotal spots 1 to 4 flow together but are recognizable as separate spots, and No. 7 is also present, small and separated from the others; spots 5 and 6 are absent. All elytral spots are present including *a,* which is always missing in *sparsa 26-punctata.*

Material examined.—Type: U.S.N.M. No. 57110, Australia: New South Wales, Richmond River.

4 paratypes all from Australia: New South Wales, Richmond River, Botany Bay (NM, AMNH).

3. EPILACHNA 28-PUNCTATA (Fabricius)

FIGURES 21, 22, 119

Coccinella 28-punctata FABRICIUS, 1775, p. 84.

Abdomen.—Abdominal lines subcomplete, reaching to within one-fourth of hind margin of first segment, outer margin nearly straight. Fifth segment, hind margin, male, slightly concave to truncate; female, truncate. Sixth segment, male, entire, convex; female, split lengthwise.

Male genitalia.—Penis seen in profile, curved upward near apex in gentle uniform curvature; no apical hook. Very narrow basal knife ridge; two rows of sparse hairs (about 0.2 mm. long) from middle to close to apex. Paramera length 1.25 mm. with apical spine. Sipho with tip rounded and with deep notch (fig. 119).

Female genitalia (as in fig. 182).—Genital plates length 0.6 mm., greatest width 0.37 mm. On the inner edge near the base an almost circular piece is cut out (diameter about 0.1 mm).

Length.—6 to 7 mm. Apex of elytra rounded.

Color and maculation.—In general all 28 spots are present. They may be small points (fig. 21) to large spots covering most of the area (fig. 22). The pronotum may vary from spotless to a pattern like that shown in figure 41. Persistent and nonpersistent elytral spots are in general equally well developed. There is not the tendency of spot *a* to disappear or other nonpersistent spots to be very small as generally observed in *sparsa*. However, occasionally some spots are absent. The under side may vary from completely light to almost completely black. Occasionally in dark specimens spots 3 and 4 or 3 and 5 lightly joined (Samoa).

The following characters are most useful to distinguish *E. 28-punctata* from species with similar appearance: Rounded apical angle of elytra; spots *cb3d* never on a straight line; genitalia of male, particularly tip of sipho; female, inner indenture of plates.

Material examined.—78 specimens, all with 28 spots except when specifically mentioned otherwise, from the following localities:

Ceylon (Weise, 1900); Ceram Island, Piroe (Mann, 1937, NGS-SI Exp., NM, 1 specimen) with spots *e, f, g,* absent; New Guinea, northeastern Papua, Mount Lamington, alt. 1,300-1,500 feet (C. T. McNamara); Solomon Islands, Guadalcanal Island, 1927 (MNH, 18 specimens), January-February 1920 (J. A. Kusche, BBM); Fulakora Island (Ch. Bignell, NM, 3 specimens); Bougainville Island, September 1944 (L. F. Gunther and R. Cross, NM). The Solomon Islands specimens, especially those of Guadalcanal, have a spotless pronotum, very small elytral spots (as in fig. 21), the apical *h* often missing, under side completely light, and size rather small. The Bougainville specimens are somewhat darker with pronotal spots 3 and 4 present, the nonpersistent spots of the elytra smaller than the persistent ones and one or two usually missing.

Australia: Northern Territory, Darwin, Stapleton (G. F. Hill, NM, 3 specimens); Roper River (N. B. Tisdale); Behn River (E. Kimberley, BBM, 3 specimens); Queensland, Gordonsvale, N. W. (J. F. Illingworth, BBM, NM); Redlynch, N. W., August 14, 1938;

Cairns (BBM); Brisbane (NM); Townsville, February 5, 1945 (B. Malkin); New South Wales, Illawarra (H. Peterson, NM); North Ryde, January 10, 1932 (R. W. Burrell, NM; A. Koebele, NM). In general the specimens from Northern Territory and North Queensland are very light with small spots similar to the Guadalcanal specimens. Occasionally spot *a* is missing. The Roper River specimens are somewhat darker, one with spot *e* missing. The specimens from South Queensland and New South Wales are dark with large spots like the Samoan specimens. A number of Australian specimens without any specific locality data are similar.

From Samoa (28 specimens): Upolu Island, Apia, January 1925 (G. H. Hopkins via Higgins, NM); Apia-Aleisa Road, 1,300 feet, on pumpkin, June 4, 1940 (O. H. Swezey, E. C. Zimmermann, BBM); Tapatapae, July 16, 1940, on pumpkin (O. H. Swezey, BBM); Tutuila Island, February (D. T. Fallaway, BBM); Savaii Island, Salailua, May 19, 1924 (E. H. Bryan, Jr., BBM).

Remarks.—As all the Samoan specimens have large spots, the space between them is small compared to the size of the spots (fig. 22); pronotum as in figures 4 E and 4 I. Under side, except part of epipleurae, completely black. Legs and last segments of antennae and maxillary palpi also black. It is peculiar that while *28-punctata* is common in Samoa, it seems to be absent from the Fiji Islands, which lie between Samoa and Australia and the Solomons where the species also occurs.

It will be very difficult to obtain complete certainty about the identity of *Coccinella 28-punctata* of Fabricius in the absence of the original type. The original description is merely: "C. coleoptris rubris: punctis nigris viginti octo. Habitat Tranquebariae. Dr. Koenig." This would fit any of the species with 28 spots. The type locality, Tranquebar, is located on the east coast of India south of Madras in latitude 11°N. In the literature since Fabricius, the name *28-punctata* has been used for at least five different species, which could not be separated by their external appearance alone. In the present paper a choice has been made that disturbs the existing nomenclature as little as possible and is not in contradiction with any of the known facts, but there is no definite proof of its correctness. The only previous reference in the literature that allows a positive recognition of the species with which the author was dealing is that of Weise (1900), who described the male genitalia of Ceylon specimens which he called *28-punctata* (Fabricius). This description agrees very well with the genitalia of the specimens from Australia and the Pacific area that I have identified with *28-punctata*

in the present paper and does not agree at all with the genitalia of *E. sparsa* (Herbst), which always has been regarded as a synonym of *28-punctata* (Fabricius) (see under *sparsa*). Since Ceylon is not far from the type locality of *28-punctata* (Fabricius), Weise's identification seems quite reasonable, and without evidence to the contrary it is best to assume that he was right. Although with this assumption it seems certain that *sparsa* and *28-punctata* are distinct species, the identity of the Australian and Pacific specimens with those from Ceylon and India, though probable from Weise's description of the genitalia,[14] should be checked by a more careful comparison, which I have been unable to make, as no specimens of *28-punctata* from much west of New Guinea have been available to me. Should the Australian specimens prove different, they would require a new name. The synonymy of this and related species would have to be changed even more if Weise's 1900 identification of *28-punctata* should prove wrong. Complete certainty in these matters can never be obtained without the type, which is apparently lost, but careful examination of fairly complete material from southern India would help a great deal. As the various species can now be told apart easily by their genitalia, much of the former uncertainty should disappear.

BIOLOGY

Biological notes for *Epilachna 28-punctata* have been published by a number of workers, but in almost all cases it is impossible to be certain whether the data refer to *28-punctata* or to one of the allied species. Contradictions in the reports on food preference probably find their explanation in the fact that the observers referred to different species. As far as the actual habits are concerned, there seems to be little difference between the species of this group, and most of what was found for *E. sparsa* will probably apply to *28-punctata*. It is obviously a tropical species and feeds on solanaceous and cucurbitaceous plants. It has been reported from Australia (New South Wales, Olliff, 1890) as one of the worst enemies of potatoes, pumpkins, and tomatoes.

Judged from the data given by the authors and the present knowledge of the geographical distribution of the various species, it is

[14] In a later paper Weise (1923a) professes ignorance about the identity of the Australian and Indian specimens of *28-punctata*. Unfortunately, he made then no use of the genitalia, and from his remarks it seems very probable that he must have had then specimens of *sparsa* that he compared with specimens of *28-punctata* from Queensland.

likely that the following biological accounts supposedly of *E. 28-punctata* refer to the species indicated:

Olliff, 1890: Australia, New South Wales—*28-punctata,* possibly *philippinensis australica.*
Fletcher, 1914: South India—*sparsa.*
Chue, 1928: South China—*sparsa* or *dentulata.*
Temperley, 1928: Australia, Queensland—*sparsa 26-punctata.*

4. EPILACHNA DENTULATA, new species

FIGURES 23-25, 120, 182

Abdomen.—Abdominal lines complete, or nearly so, subterminal, angulate or subangulate. Fifth segment, male, hind margin slightly concave with a very slight median process; female, truncate. Sixth segment, subtruncate to convex in male, split in female.

Male genitalia.—Penis in profile, length 1.4 mm., with apical end gently curved on both upper and lower edge. Total bend about 45°. No apical hook. Seen from below, orifice elongately oval. Penis at apex of orifice about 0.1 mm. wide, length from orifice to apex 0.2 mm., uniformly narrowed to point. On upper side with 3 to 6 low transverse ridges, which appear as small teeth seen in profile. These occasionally may practically disappear. Paramera 1.4 mm. long, of nearly equal width (0.15 mm.), with apical thorn. Rim covered with hairs on apical half (about 0.2 mm. long). Sipho of normal shape, ending in point. Orifice on side, subapical, oval.

The shape of the male genitalia is the same as those of *28-punctata.* They differ by the presence of the dentules and the structure of the tip of the sipho, which is more like that of *sparsa* and *philippinensis* (see fig. 118).

Female genitalia.—Very much like those of *28-punctata.* The borders of the notch near base of inner edge dark.

Length.—6.5 to 7.2 mm. Apical angle of elytra rounded.

Color and maculation.—Upper side brownish red. Pronotum varying from spotless to one with all seven spots present. Pubescence light gray, dark on the spots. Elytra with all 28 spots arranged as in *28-punctata.* Indochina specimens with small spots, Philippine specimens with larger ones.

Material examined.—30 specimens.

Type: U.S.N.M. No. 57111, from Cochin China, Trang Bom, 30 miles northwest of Saigon (M. Poilane, 1932).

17 paratypes, 5 from the same locality, others from: Cochin China, Bienhoa Prov., Trang Bom Arboretum, August 12, 1932, September

1, 1932 (M. Poilane), and 58 km. from Colonial R.-20, alt. 100 meters, October 26, 1932 (M. Poilane, NM). Philippine Islands: Bataan Prov., Limay, November 1924 (R. C. McGregor, NM); Lanao, March-June 1911 (C. V. Piper, NM); Los Baños (Baker).

Additional specimens from: China, Soochow (?), Foochow. Cochin China, Bienhoa Prov., Trang Bom Arboretum, September 4-9, 1932 (M. Poilane, NM). Flores Island, Larantuka (female might be *28-punctata*) (F. Knab, 1917, NM.). Philippine Islands: Luzón, Ilocos Sur (McGregor, NM); Luzón, January 16, 1920 (MNH); Manila, December 1924 (McGregor, NM).

Remarks.—This species is very close to *28-punctata* (Fabricius). It can positively be distinguished from it by the differences in the tip of the sipho and the ridges on the penis, although the latter may occasionally tend to become obsolete. The two species do not seem to overlap geographically, and further data may disclose that *dentulata* should be regarded as a subspecies of *28-punctata*. If it is true that the two species do not overlap geographically, the locality of a specimen will give the best clue as to which species a specimen belongs. This will help especially in the case of females, which are otherwise difficult to separate.

The other species with 28 spots occurring in the same region are *E. sparsa, E. philippinensis,* and *Afidenta mimetica.* From all three it can be definitely separated by the genitalia and from the first two in addition by the fact that the tips of the elytra are rounded and do not show a definite angle. From *Afidenta mimetica* it differs by the maculation of the pronotum (if any) and the structure of the claws and abdomen.

EPILACHNA DENTULATA subsp. PARVINOTATA, new subspecies

FIGURES 24, 25

This is the 12-spotted form of *dentulata.* The structural characters including the genitalia are the same, but there are only six spots on each elytron. Since the geographical distribution of the two forms does not seem to overlap substantially, we may regard them as true subspecies.

The maculation of the elytra of *parvinotata* shows considerable variation with locality, and so it might be subdivided further into several subspecies.

The pronotum is spotless in all but the Indian specimens, which have spots 1 to 4 and 7. The elytral spots are very variable in size (see figs. 24 and 25, which show the extremes). The front tangent

to spot 1 usually passes the suture well behind the tip of the scutellum, but when the spots are strongly developed it may cut the scutellem near the apical end. Spots 1 and 5 in that case touch the suture. No. 4 touches the side margin or almost so.

Material examined.—More than 60 specimens (NM).

Type: U.S.N.M. No. 57112, Philippine Islands, Mindanao, Dapitan (Baker).

Paratypes: From the Philippines: Mindoro Island, Port Galera (McGregor); Samar Island, June 8, 1924 (McGregor); Sulu Islands, Boñgoa, July 1924 (A. Duyag); Negros Occidental, Cádiz, December 4, 1929; Manapla, June 25, 1929, on cane; Victorias, August 25, 1928, on *Physalis*. From Celebes Island, Macassar.

Further specimens from: Lower Siam: Trong (W. L. Abbott), spot 1 practically absent. Borneo: Sandakan (Baker), Banguey Island (to north of Borneo). Moluccas: Batjan Island, August-September; Sula Island (Doherty); these specimens have the spots very large. Java-Sumatra: Padang. India: Sikkim Prov., Darjeeling, June, 2 specimens both with rather large elytral spots and pronotum with spots 1-4 and 7.

This subspecies of *dentulata* seems to occur over a wide territory. I have found this form in collections under the names *taeniata, dodecostigma, sparsa, pusillanima,* and others. It is more than likely that the forms from the Indian or the Western Archipelago have been described previously under one of these or possibly another name. However, at present only guesswork could say which one. Therefore it is possible that after examination of the types the synonymy of *E. dentulata* will have to be revised.

5. EPILACHNA REDUCTA, new species

FIGURE 26

Abdomen.—Abdominal lines complete, subangulate, reaching to within one-fourth to one-fifth of hind margin, variable. Fifth segment male, hind margin truncate to slightly concave; female, truncate. Sixth segment, male, truncate or slightly convex; female, split, apical corners distinct. Abdominal segments with shallow impressions on sides.

Male genitalia.—Penis seen in profile, 1.15 mm. long, widened near base, basal knife edge present. Middle part with parallel edges 1.15 mm. wide, bent upward near apex through angle of nearly 90°. No hairs on penis. Seen from below, uniformly narrowing from base to apex, width at base 0.2 mm., at apex of orifice 0.07 mm. ending

in sharp point. Paramera 1.11 mm. long, gently bent outward near base, slightly widened toward apex, maximum width 0.13 mm. Apical thorn present but not very prominent. Rim of apical third covered with light blond hairs (about 0.2 mm. long). Sipho normal shape, tip emarginate.

Female genitalia.—Apex of tergite X broadly truncate, shape of genital plates like *28-punctata,* notch near base of inner edge narrow and deep.

Length.—6 to 6.5 mm. Tips of elytra rounded.

Color and maculation.—Upper side light brownish red. Pronotum black with light edges (as in fig. 4 K, a little toward 4 J). Elytra with 13 spots each, *a* missing or possibly united with No. 2. Spots large and showing a tendency to be elongated. Under side except head black, epipleurae, tarsi, antennae, and mouth parts light, femora and tibiae black with light tips.

Material examined.—7 specimens, as follows:

Type: U.S.N.M. No. 57113, Philippine Islands, Luzón, Benguet Prov., Baguio, (Baker).

6 paratypes, same locality (Baker, G. G. Haslam, McGregor, NM).

All specimens are very much alike in color and maculation except one which has lighter tibiae.

Remarks.—*E. reducta* can easily be recognized by its elytral markings. It is more slender than *sparsa, 28-punctata,* and allied species, from which it is also easily separated by its genitalia. In the structure of the male genitalia it is closest to *E. emarginata* (fig. 125). The genitalia of these two species are practically identical in structure, but the two species differ considerably in external appearance.

6. EPILACHNA EMARGINATA, new species

FIGURES 34, 125, 195

Abdomen.—Abdominal lines complete, subterminal. Fifth segment with hind margin truncate in both sexes. Sixth segment, male, hind margin slightly emarginate; female, split; apical angles sharp.

Male genitalia.—Penis seen in profile, 1.4 mm. long, with rudimentary basal knife edge; curvature uniform, very sparse pubescence with only a few hairs present. Paramera 1.3 mm. long with apical thorn, slender (greatest width little over 0.1 mm.), sparsely pubescent with light hairs on apical third. Sipho with tip emarginate.

Female genitalia.—Plates 0.43 mm. long, greatest width 0.27 mm.; lateral edge almost semicircular; notch on inner edge near base, pointing somewhat backward.

Length.—6 mm. Tips of elytra with distinct angles.

Color and maculation.—Upper side red, pronotum spotless, elytra each with six black spots. No. 1 usually very small, in one specimen absent. (Fig. 34 was made from a specimen that had this spot unusually large.) The other spots rounded, No. 4 touching the margin in specimens where the spots are large. Under side light, metasternum darker.

Material examined.—6 specimens, as follows:

Type: U.S.N.M. No. 57114, Philippine Islands, Samar Island, May 30, 1924 (McGregor).

5 paratypes: Samar Island, May 26, 1924 (McGregor, NM), and Bho (NM).

Remarks.—The male genitalia of this species are very similar to those of *E. reducta,* which is the only other species with the tip of the sipho emarginate.

EPILACHNA EMARGINATA subsp. ALTERA, new subspecies

This is the multipunctate form of *E. emarginata* that, as in several other species, seems to occur as subspecies on Luzón and also on Mindanao. All specimens have all the spots except *a.* No. 1 is of normal size.

Material examined.—Type: U.S.N.M. No. 57115, Philippine Islands, Luzón, Mount Banájao (Baker).

Paratype: Luzón, Benguet, Irisan, June 1903 (R. C. McGregor); Los Baños (Baker, MCZ).

Additional specimens: Mindanao, Zamboanga (MCZ).

7. EPILACHNA NIPONICA Lewis

FIGURES 27, 28, 122

Epilachna niponica LEWIS, 1896, p. 23.
? *Epilachna 28-maculata* MOTSCHULSKY, 1857, p. 40.

Abdomen.—Abdominal plates complete, subterminal, rounded. Fifth segment, male, hind margin mildly concave; female, truncate with a depression in the middle of apical half. Sixth segment, male, emarginate; female, split.

Male genitalia.—Penis seen in profile, small basal knife ridge. Penis tube straight for the major part with parallel edges, 1.7 mm. long. Curved near apex through approximately 90°, curvature strongest just before tip, without, however, forming a hook. Upper side with hairs from about one-third to five-sixths from the base. Three to six (usually about 4) teeth leaning backward toward base

on upper side, variable in size. Penis seen from below, tube gradually narrowed from base to apex. Part beyond orifice short (0.2 mm.) and wide (0.17 mm. at apex of orifice narrowing uniformly toward apical point). Paramera 1.6 mm. long, 0.1 mm. wide, subparallel for apical two-thirds, gently curved down near apex, with apical spine. A single sparse row of hairs on apical two-thirds with traces of additional hairs. More densely clothed with hairs immediately near apex. Sipho profile of tip, see figure 122 (different from that of any other species).

Female genitalia.—Very similar to those of *E. sparsa,* possibly a little wider. Length of plates 0.53 mm., greatest width 0.37 mm. Notch near base of inner margin shallow, elongately diamond-shaped.

Length.—6.5 to 8 mm. Tips of elytra rounded.

Color and maculation.—Upper side light reddish brown; head often with two confluent dark spots at middle of base. Pronotum with spots 3, 4, and 7 united in a median spot (fig. 4 I). Spots 1 and 5 often united (fig. 4 J). However, also lighter specimens occur with practically spotless pronotum and dark ones where the pronotum is completely black except for a narrow front and side margin (fig. 4 K). Elytra with the full complement of 28 spots. The nonpersistent ones nearly as fully developed as the persistent ones. I have seen no specimen with any spot missing. Spots *cb3d* never approximately on a straight line. Under side and appendages light in the lighter specimens with the sides of metasternum and the middle of the basal abdominal segments dark. In the darker specimens the dark color spreads over the whole under side including spots on the femora and the elytral epipleurae. However, even in very dark specimens, the depression in the middle of the fifth abdominal segment of the female is light.

Distribution.—Takahashi (1932) has made a detailed study of the distribution of *E. niponica* Lewis in Japan. The species occurs in the northern parts and the mountainous parts of the southern sections. The southern limit is roughly where the mean annual temperature becomes higher than 15°C. This means in Japan a latitude of about 32.5°N. It seems that *niponica* will not hatch when the temperature is above 32°C., as the eggs perish. This may be the reason for the limit of distribution. *E. sparsa* needs a mean annual temperature of 15°C. or more. There is only a relatively narrow region between the isotherms 14°C. and 15°C. where both species occur.

Material examined.—More than 160 specimens (NM, MNH, BM), from Japan, China, and Siberia:

Japan: Sapporo, May 10-11, 1928, July 24, 1927 (T. R. Gardner);

Karuizawa Mountains (NM); Takada, July 13, 1930 (H. Suguira, NM); Koebele (NM); Yokohama, Kagoshima (NM).

China: Peking; Tsing Ling Shan, 65 miles northeast of Peking; Peking, summer 1913 (F. N. Meyer, NM); Chih-li Prov., Hsiao Wu Tai Shan (F. N. Meyer, NM); Pei-tai Ho near Shanhai-kuan, Chih-li Coast, August 1914 (A. DeC. Sowerby, NM); Kiang-su Prov., Soochow, N. Gist Gee (NM); Jehol Prov., Yuasa, 1936; Ming Chiang, Foochow, June 1926 (F. P. Metcalf, NM).

Manchuria: N. Kirin, I-mien-po (Sowerby, NM); Darien, Sokin, August 1936 (Flexier).

Southern Korea: Mount Chiisan, July 23-August 7, 1935 (D. M. Suk, NM).

Siberia: Vladivostok, 1923 (V. Prinada, NM); Okeanskaya, 1923 (Corkerell, NM); Kongaus, August 1923 (Lavrushin, NM).

Remarks.—The nomenclature of this species has been quite confused, and even more so the identity of *E. 28-maculata* Motschulsky. Motschulsky described *Epilachna 28-maculata* in 1857 from specimens from Shimoda, Japan, and eastern Siberia. The description would fit any of the species with 28 spots and is therefore entirely inadequate for a diagnosis. Subsequent authors have applied the name *28-maculata* with about equal frequency to two species, which are called in the present paper *E. sparsa orientalis,* new subspecies, and *E. niponica* Lewis. We know enough about the fauna of Japan and eastern Asia to be certain that Motschulsky's *28-maculata* must be one of these two.

Unfortunately the type locality Shimoda on Izu Peninsula is not among the localities where detailed observations on the distribution of the two species were made by Takahashi (1932), but it lies in the general region where both species may be expected. Takahashi's observations seem to show that *niponica* does not occur in the low-lying parts of the Tokyo district and therefore would not be expected to occur at Shimoda, which has an even milder climate. On the other hand, Lewis (1896) reported his *28-maculata,* which is almost certainly identical with *niponica,* from Yokohama, and, of course, Motschulsky might have obtained his type specimens of *28-maculata* from the mountains near Shimoda, where *niponica* is almost certain to occur. Therefore, the type locality unfortunately gives no definite clue to the identity of Motschulsky's *28-maculata.* Motschulsky gives as second locality for his type series "Eastern Siberia," which is beyond the range of *sparsa orientalis* and would therefore settle the question about the identity of *28-maculata,* if we could be sure that the Siberian and Japanese specimens that Motschulsky had before

him actually belonged to the same species, which can be settled now only by a reexamination of the types. Until this has been done, I prefer provisionally to retain Lewis's name *E. niponica,* which has never been applied to any but the present species, and this cannot possibly lead to any further confusion. Should Motschulsky's type from Shimoda be found to be identical with *niponica* Lewis, then this name would have to be dropped as synonym of *28-maculata* Motschulsky. This would still be true if the Japanese specimen should turn out to be identical with *sparsa orientalis,* but as holotype of *28-maculata* a Siberian specimen of Motschulsky's type series would be selected.

Lewis (1896) in his list of Japanese Coccinellidae gave the description of three 28-spotted species of *Epilachna.* His *28-punctata* is *E. sparsa orientalis* of the present paper. From our present knowledge of the Japanese *Epilachna* it is apparent that Lewis's description of *28-maculata* Motschulsky and *niponica* Lewis very probably refer to a light and dark form of the same species (corresponding to figs. 27 and 28) so similar as not even to deserve varietal names. All the intermediates between these two forms can be observed. Lewis states in the original description of *niponica:* "The abdomen, fourth segment of the male is canaliculate in the middle, surface of the channel usually red, rarely black," and this statement is repeated by Mader (1926). In all the specimens I have seen the *fifth* segment of the *female* has this property instead of the *fourth* segment of the *male.*

It is clear, therefore, that *niponica* Lewis is synonymous with *28-maculata* Motschulsky subject to a confirmation from Motschulsky's type. The continued use of *niponica* Lewis in this paper is only provisional.

BIOLOGY

The biology of *Epilachna niponica* Lewis in Japan has been studied by several observers, probably most in detail by Takahashi (1932). It has two generations in most of Japan, but only one in the northern parts (Hokkaido). Reports that it should have three generations in southern Korea are questionable.

The eggs are laid in open clusters on the under side of leaves of the food plant, while *sparsa* has closed egg clusters. The number of eggs laid by one female under laboratory conditions was 222 to 896, average 445. The duration of the various stages is: egg 3 to 11 days: larvae 14 to 27 days (4 instars); pupa 4 to 8 days; egg to emergence of adult 25 to 45 days; oviposition period 17 to 40 days; end of egg laying to death 2 to 29 days (average 15). The lower limits are for the warmer, the upper for the cooler periods.

The beetle hibernates as adult. Activity begins from the middle of March to the middle of April, and the beetles appear all at once. They disappear for hibernation from the beginning of October to November.

E. niponica is said to injure more than 30 species of plants. According to Takahashi, the principal food plants are:

SOLANACEAE

1. *Solanum tuberosum* L. Potato.
2. *Solanum melongena esculentum* Nees. Eggplant.
3. *Solanum nigrum* L.
4. *Solanum ovigerum* Dan.
5. *Physalis alkekengi* L.
6. *Physalis angulata* L.
7. *Lycopersicum esculentum* Mill. Tomato.
8. *Datura alba* Nees.
9. *Capsicum annurum* L. Red pepper.

CUCURBITACEAE

10. *Cucumis sativus* L. Cucumber.
11. *Cucurbita muscata toonas* Mak. Squash.

LEGUMINOSAE

12. *Phaseolus vulgaris* L. Bean.
13. *Glycine soja* Benth. Soybean.

COMPOSITAE

14. *Arctium lappa* L.

CRUCIFERAE

15. *Brassica campestris* L.

Nos. 1 and 2 are most commonly injured, then 3 and 7. No. 5 is seldom attacked and in this respect *niponica* differs from *sparsa orientalis* for this is the latter's preferred food plant. No. 15 is eaten in autumn when there is little other food.

EPILACHNA NIPONICA subsp. COALESCENS Mader

FIGURES 29, 30

Epilachna 28-maculata a. *coalescens* MADER, 1930, p. 184.

This seems a well-defined subspecies occurring in the mountains of Szechwan, China. It differs from the ground form by the confluence of a number of spots, which in the fully developed form takes the appearance of figure 30, with the following spots confluent: $2+1+1$, $b+c$, $3+d+d$, $e+f$, $g+h$. The pronotum is black with a narrow front and side margin black. The pubescence of the elytra is gray all over, while in the ground form it is black on the dark spots. This makes the spots much more indistinct in appearance. The male genitalia, though on the whole identical in appearance, seem to be somewhat shorter, and the paramera may be twice as wide (0.2 mm.) as in the typical Japanese specimens.

Mader described this form as an aberration of *E. 28-maculata.* He does not mention the difference in the color of the elytral pubescence, but there seems little doubt that he must have this same form before him.

Type locality.—China, Szechwan Prov.

Material examined.—56 specimens, all from China, Szechwan Prov. (D. C. Graham, NM), (except 2 specimens from Tibet, MNH): Den Shiang Uen near Ningyuenfu, alt. 8,000-9,500 feet, August 4-6, 9-10, 1928; between Ningyuenfu and Den Shiang Uen, alt. 6,000-8,000 feet, August 6-8, 1928; Ningyuenfu, alt. 6,200 feet, July 31, 1928; near Wen Chuan, alt. 4,000-6,000 feet, May-August 1933; Uin Gin Shien, alt. 2,500-7,000 feet, July 14-15, 1928; near Fu Liu, alt. 5,000-8,200 feet, July 19-21, 1928; Mupin, alt. 5,000-6,000 feet, July 19, 1929; Mupin, August 25-28, 1929; Tatsienlu, alt. 5,000-8,500 feet, August 7, 1923; Tatsienlu, alt. 300 feet, August 16, 1930; near Yachow, alt. 2,800-4,000 feet, July 8, 1930, June 16-20, 1923; 35 miles west of Tatsienlu, alt. 5,000 feet, June 20, 1923; near Li To, alt. 5,000-9,000 feet, August 21, 1930; Shin Kai Si, Mount Omei, alt. 4,400 feet, July 6-16, 1934, August 1921; Si Gi Pin, Mount Omei, alt. 6,000 feet, August 6-15, 1925; Kuanhsien, alt. 2,200-5,200 feet, July 19-20, 1933; Yao Gi near Mupin, alt. 7,000 feet, July 17, 1929; near Mupin, 3,000-7,400 feet, July 1-3, 1929; near Hai Tang, alt. 6,000-8,000 feet, August 4, 1928; between Yachow and Suifu, alt. 1,000-2,500 feet, January 15-24, 1929; Yachow, alt. 2,000, July 1928.

There are three specimens with uniformly gray pubescence on the elytra but with all the spots separated. China: Chih-li Prov., Pei-tai Ho near Shanhai-kuan, August 1914 (A. DeC. Sowerby, NM).

8. EPILACHNA WISSMANNI Mulsant

FIGURES 31, 123, 190

E[*pilachna*] *Wissmanni* MULSANT, 1850, p. 832.

Abdomen.—Abdominal lines subcomplete, subangulate, reaching to within one-fifth of the hind margin of the first segment. Fifth segment, male, hind margin very distinctly and broadly emarginate; female, subtruncate with a faint middle process, sixth segment, male, with a deep notch; female, split.

Male genitalia.—Penis seen in profile, length 2.8 mm., lower edge straight for about 2.1 mm., then gently curved up to the sharp apical point. The curved part with a distinct emargination (as in *sparsa*),

upper edge with a distinct basal knife edge, the apical part in a gentle arc curved upward; a slight bulge corresponds to the emargination on the lower side. This curved part furnished with hairs. Seen from below, closed tube for 1.9 mm., then elongate diamond-shaped orifice about 0.5 mm. long beyond that narrow edge to apical point. Paramera 2.5 mm. long, compressed for apical two-thirds, widened near apex, with apical thorn and with two rows of hairs on apical third (0.1 to 0.3 mm. long). Sipho with a blunt right-angle bend near base ending in a long and slender point with a very elongate orifice.

Female genitalia.—Genital plates, length 0.67 mm., width 0.44 mm., with a characteristic emargination about the middle of the inner margin.

Length.—9 to 10 mm. Apical angle of elytra distinct. Beetle heart-shaped, strongly convex.

Color and maculation.—Upper side light brownish red to brick red; pronotum spotless. Elytra with the six persistent spots rounded except No. 4, which is laterally widened to the margin. Nos. 1 and 5 separated from the suture. Common front tangent to the two No. 1 spots passing approximately through the tip of the scutellum. In addition, nonpersistent spot *c* present; size of it from very small to close to size of the persistent spots. In one specimen there is also a faint indication of spot *d*. Under side and appendages light; the elytral spot 4 reaches over three-fourths of the width of the epipleurae.

Type locality.—Celebes.

Material examined.—8 specimens (NM, MCZ) from Celebes: Bantimoerong (Mann, 1937); South Celebes, Bonthain (C. Ribble, 1882, 1883); North Celebes, Toli-Toli; Patutuang, Malino (Brues).

9. EPILACHNA BAKERI, new species

FIGURES 31, 124, 191

A species very similar to *wissmanni* in shape and maculation but slightly smaller. It differs from *wissmanni* distinctly by the structure of the genitalia.

Abdomen.—Abdominal lines somewhat variable. Fifth segment, male, hind margin concave; female, straight. Sixth segment, male, with shallow notch; female, split.

Male genitalia.—Penis seen in profile, lower edge practically straight until close to apex, then gentle curvature up to fine apical point; well-developed basal knife ridge on upper side, a little

thickened just before apex, but this sometimes hardly noticeable. Sparse growth of hair, about 0.1 mm. long on apical third. Paramera 2.0 mm. long with apical thorn. Sipho curved near base, then straight, tip compressed, one sharp edge, and on the other side the very elongate orifice.

Female genitalia.—Genital plates 0.60 mm. long, greatest width 0.39 mm., with a feeble emargination on the inner edge about one-third from the base.

Length.—8 to 9 mm. Shape broadly heart-shaped, convex. Apical angle of elytra slightly indicated.

Color and maculation.—Upper side yellowish red, pronotum spotless, elytra usually with seven spots (*c* in addition to the six persistent ones, the former of varying size and occasionally absent). No. 1 near suture but not quite touching it; a line tangent to the front margins usually cuts the scutellum in half. Occasionally elongated forward and almost touching the base; Nos. 3 and 4 transversely broadened, No. 4 touching the margin and partly visible on epipleurae. Under side light except the sides of metasternum.

Material examined.—Type: U.S.N.M. No. 57116, Philippine Islands, Mindanao, Dapitan (Baker).

14 paratypes (NM, MCZ, D): Mindanao Island, Dapitan, Tutuan, Surigao (Baker), Cabadharan (C. S. Banks); Northwestern Panay Island; Polillo Island; Biliran Island (Baker).

EPILACHNA BAKERI subsp. LUZONICA, new subspecies

FIGURE 32

Identical in most respects with the preceding except for the following differences, which, however, seem not sufficiently important to warrant its being considered as a separate species:

The profile of the penis is slightly different. The upper edge is more nearly straight, but the lower one has an emargination before the apex and ends in a definite hook. The most conspicuous difference is in the presence of additional nonpersistent spots, which occur as follows in the five available specimens (all from Luzón, P. I., coll. Baker and McGregor, NM) (for the notation of spots cf. fig. 7):

Type: U.S.N.M. No. 57117, Philippine Islands, Luzón, Mount Maquíling (Baker), with all spots except *a*, but the nonpersistent spots very small.

4 paratypes: (1) female, Mount Maquíling (Baker); spots like the type but also *a* present, though very faintly; (2) female, Mount

Maquíling (Baker); spots *a, b, c, d, h: c* large, *b* medium, the others small; (3) male, Nueva Vizcaya Prov., Imugan; spots, *c* large, *b* and *h* small; (4) female, Ilocos Sur (McGregor); all spots except *a* of about the same size as the persistent spots; *a* also present, but very small.

We have here another instance of the occurrence of two forms, one with approximately the full number, 28, of spots, and one with only 12 or 14 spots. As in several other cases, the multipunctate form occurs on Luzón, whereas we find the form with the reduced number of spots on the outlying islands.

10. EPILACHNA SEPTIMA, new species

FIGURE 220

Abdomen.—Abdominal plates complete, subterminal. Fifth segment, male, truncate; female, with a broad triangular process in middle. Sixth segment, male, hind margin convex; female, split, apical angles of parts distinct.

Male genitalia.—Penis seen in profile, 1.8 mm. long, with distinct basal knife edge, straight and of approximately equal thickness for about four-fifths of its length, then bent up first gently and shortly before the end more strongly through about 90°. Apical point with a trace of a hook. On upper side with two sparse rows of hairs on middle part. Seen from below, tube about 0.25 mm. wide from base to orifice, the latter elongate. Tube closed for first 0.15 mm., then seams about 0.03 mm. apart, closing toward the middle and diverging again near the orifice. Part beyond the orifice, subparallel, slightly widening toward apex, about 0.065 mm. wide immediately beyond orifice, about 0.3 mm. from orifice to apex. Paramera 1.7 mm. long, thicker than wide except near apex, greatest width near apex 0.15 mm., no distinct apical thorn, pubescence on apical third rather short and sparse. Sipho regular shape as in figure 123, including the compressed part near the tip; detail of tip, figure 220.

Female genitalia.—Shape of plates very much as in *E. wissmanni* Mulsant (fig. 190). Length 0.63 mm., greatest width 0.37 mm.

Length.—6.5 to 7.0 mm. Tips of elytra rounded.

Color and maculation.—Very much like that of the other 28-spotted species. Pronotum with all spots except 7 present but hazy. All 14 elytral spots present and more or less rounded, the persistent spots on the whole bigger than the nonpersistent ones. None of the spots touching the suture or the margin. Joint front tangent of No. 1 passing the suture behind the scutellum. Under side mostly light except parts of metasternum.

Material examined.—Type: U.S.N.M. No. 57963, from Indochina, Annam, Phuc-son, November-December.

1 paratype (D), with same data.

Remarks.—*E. septima* is so much like other 28-spotted species that it can be clearly recognized only by the genitalia. Those of the male are different from those of any other known species. There are other species with the *wissmanni* type of female genitalia, however, none with the same external appearance.

E. septima might with superficial inspection be confused with the following species of the same general appearance known to occur in the same region: *E. sparsa, E. dentulata, Afidenta mimetica. E. sparsa* has sharp elytral tips, and *A. mimetica* is sufficiently different by the generic characters. From *E. dentulata, septima* differs definitely by the structure of both the male and the female genitalia. Also, *dentulata* has spot 4 joined to the margin, while it is free in *septima.* This may be a safe criterion for separating the two species without dissection.

11. EPILACHNA DIFFINIS (Eydoux and Souleyet)

FIGURES 33, 121

Coccinella diffinis EYDOUX and SOULEYET, 1839, p. 267.
E[pilachna] diffinis MULSANT, 1850, p. 783.

Abdomen.—Abdominal plates subterminal, not quite complete to complete; inner margin curved, outer margin nearly straight. Fifth segment, male, hind margin concave; female, truncate. Sixth segment, male, with considerable emargination; female, split.

Male genitalia.—Penis seen in profile, bent upward near apical fourth, on the under side with slight emargination after the bend, with apical hook. Basal knife ridge present, sparse pubescence; on middle part of upper side four transverse ridges which appear like teeth in profile. Paramera slender, 1.8 mm. long, with apical thorn and relatively short and sparse pubescence. Sipho as in *sparsa,* ending in sharp point with orifice oval on outside.

Female genitalia.—Plates, length 0.57 mm., greatest width 0.38 mm., gentle emargination on inside edge near base.

Length.—7.2 to 8.0 mm. Shape oval, apical angles of elytra distinct.

Color and maculation.—Upper side reddish, pronotum spotless or with faint indications of spots 1-4. Elytra with six spots each, none touching the margin or the suture, pubescence light gray, dark on the spots but occasionally specimens with gray pubescence through-

out (subsp. *signatula* Mulsant). Color of spots often brown instead of black, size variable from about 0.4 to 1.3 mm. in diameter. Under side light, except metasternum and central basal part of abdomen, which are usually darker.

Remarks.—This species agrees very well with the detailed description of *diffinis* given by Mulsant. The only difference is in the maculation of the pronotum, which according to Mulsant should have spots 1 and 2 present, while in the specimens I have seen it is usually spotless or, when there are spots, 1 to 4 are present. As the pronotal spots are extremely variable in nearly all species, not much importance need be attached to this difference. Since Mulsant, 1850, repeated by Crotch, 1874, *diffinis* has not been mentioned again in the literature. Weise (1913) and Schultze (1925) mention *E. pusillanima* Mulsant in their list of Philippine beetles. Judged from the number of cited localities, it must be one of the most abundant species of *Epilachna* in the Philippines, and I believe that their *pusillanima* is identical with *diffinis* Eydoux and Souleyet. The type locality of *pusillanima* is Java, and its description is very little different from that of *diffinis*. I have not been able to identify it with certainty but suspect that it is one of the forms of *sparsa*.

EPILACHNA DIFFINIS subsp. SIGNATULA Mulsant

E[pilachna] signatula MULSANT, 1850, p. 784.

Mulsant gives a variety, *signatula* Mulsant, that differs from the ground form in that the line joining the fifth and third spots, instead of passing over the callus, passes it on the inside. The specimens from Luzón are of this type. They have uniform gray pubescence all over the elytra but do not differ in the structure of the genitalia. It is reasonable to consider this form as a subspecies.

Type locality.—Philippine Islands, Luzón, Manila.

Distribution of diffinis, *including subspecies* signatula.—57 specimens (all NM): Luzón Island, Mount Maquíling and Los Baños; Bataan Prov., Limay; Sulu Islands (17 specimens), from Jolo, Mount Budaho, and Mount Daho (McGregor); Banaran Island (McGregor); Boñgao, July 24 (A. Duyag); Basilan Island (Baker); Palawan Island, Puerto Princesa (Baker); Mindanao Island, Mount Apo, June, July (E. A. Mearns); Dávao (Baker); Dávao, June 1927 (McGregor); Dapitan (Baker); Iligan (Baker); and one from Mindanao, May 1911 (C. V. Piper).

Remarks.—*Epilachna diffinis* can easily be distinguished from all other species by its male genitalia. The few species (*dentulata* and

niponica) that also have similar ridges on the upper side of the penis differ so much in other respects that no confusion is possible.

12. EPILACHNA ELONGATA, new species

FIGURE 37

Abdomen.—Abdominal plates subterminal, not quite complete. Fifth segment, female, with hind margin truncate with an indistinct middle process; sixth segment split.

Female genitalia.—Plates, length 0.57 mm., greatest width 0.33 mm.; inside edge with a very shallow notch near base. Outer part of apical edge straight. (This part is concave in *diffinis,* and this difference seems to be the easiest way to tell the genitalia of the two species apart. The plates in *diffinis* are slightly wider.)

Length.—7.5 mm. Tips of elytra with quite distinct angle. Shape elongate.

Color and maculation.—Upper side red, pronotum spotless. Elytra each with six fairly large spots; No. 1 elongate and not quite touching the suture, No. 4 joined to the margin. The spots quite black in color and contrasting sharply with the red ground color. (In *diffinis* the spots are not so black or the ground color so bright.) Under side light, with metasternum and parts of abdomen darker. Clypeus with front edge concave. (This is slightly convex or straight in *diffinis.*)

Type.—U.S.N.M. No. 57118, Philippine Islands, Mindanao, Iligan (Baker).

Remarks.—Although this specimen, because of its narrower and more convex shape, its larger spots and brighter colors, gives an impression quite different from all the *diffinis* specimens, there are few definite characters that separate the two species. Those mentioned in the description are slight but apparently valid. Unfortunately, males which probably would permit much more definite conclusions are not available.

13. EPILACHNA MINDANAONIS, new species

FIGURES 35, 126, 193

Abdomen.—Abdominal lines complete, subterminal, rounded, reaching to within 0.1 to 0.2 mm. of the hind margin of the first segment. Fifth segment, male, hind margin concave; female, truncate. Sixth segment, male, slightly emarginate; female, split, tips rounded off.

Male genitalia.—Penis seen in profile, 1.5 mm. long, curved gently up near apex, the curved part very thin. From base to the beginning of the curvature, wedge-shaped with the broad end 0.3 mm. wide near the base. Only a rudimentary basal knife edge. Just before the beginning of the curved part a tuft of long hairs (0.5 mm. long or longer), the hairy part extending only 0.2 to 0.3 mm. Paramera 1.4 mm. long, gently curved outward near base, slightly widened toward apex, no apical spine, densely covered with long (0.4 mm.) hairs on rim of apical part. Sipho ending in sharp point (as in *sparsa* or *philippinensis*), orifice on side at apex, just before it a short tonguelike process.

Female genitalia.—Length of genital plates 0.48 mm., greatest width 0.31 mm. The notch on inner edge enlarged so that it covers almost the entire edge concave inward with a sharp edge only at the basal part. This gives the plates almost crescent shape. No similar structure known for any other species.

Length.—7 to 7.5 mm. Tips of elytra with slight indication of angle. Shape broadly oval, convex.

Color and maculation.—Upper side light brownish red. Elytra each with six rounded spots; Nos. 1 and 5 smaller than the others, close to the suture but not quite touching it. Front tangent to No. 1 through tip of scutellum. No. 4 not touching the margin. Under side and appendages light except tip of mandibles and metasternum and sometimes part of the abdomen, which are darker. Line through middle of spots 3 and 5 touches outside of No. 2.

Material examined.—Type: U.S.N.M. No. 57119, Philippine Islands, Mindanao, Butuan (Baker).

6 paratypes: Mindanao, Butuan, Surigao (Baker, NM); Samar Island, July 21, 1924 (McGregor).

Remarks.—This species is hardly different in external appearance from many others but is very well characterized by its male and female genitalia, and it can easily be separated by them from species of similar appearance.

14. EPILACHNA DUBIOSA, new species

FIGURES 36, 127

Abdomen.—Abdominal lines incomplete, subterminal. Fifth segment, male, hind margin a very shallow V; female, truncate. Sixth segment, male, with decided emargination or notch; female, split, apical angles distinct.

Male genitalia.—Penis seen in profile, 2.1 mm. long, with pro-

nounced basal knife ridge. Upper edge gently curved, coming to a point with the indications of a tiny hook. Apical half sparsely covered with hairs about 0.3 mm. long. Seen from below, orifice elongately diamond-shaped, the part from orifice to tip a sharp ridge about 0.3 mm. long. Paramera slender, 2.0 mm. long. Seen from above, greatest width near apex, about 0.13 mm. A sharp apical ridge instead of the usual apical thorn, sparse pubescence on apical third. Sipho ending in blunt point compressed sidewise near apex, orifice on side oval, elongate with liplike process.

The *female genitalia* of subspecies *assamensis* are described below. A female specimen from Borneo has the same structure of the genitalia. The difference in geographical location makes it, however, less certain that this is actually the female of *dubiosa.*

Length.—7.5 mm. Shape broadly oval, convex. Tips of elytra rounded.

Color and maculation.—Upper side red, pronotum with only spots 1 and 2, faint. Elytra each with six spots: No. 1 beginning well behind the scutellum, No. 4 not touching the margin. Under side light except parts of metasternum, which are darker. Faint dark spots at the sides of the abdominal segments.

Material examined.—Type: U.S.N.M. No. 57120, India, Goa, Murmugao (Bridwell).

1 female: Borneo, Sandakan (Baker, D).

Remarks.—This is a species very similar in external appearance to others of the 12-spotted species but distinguished by its genitalia. Its appearance does not seem to agree exactly with that of any of the described species, but there are so few distinguishing marks that it is impossible to be sure. The female specimen has much the same external appearance as the type and the same structure of the female genitalia as subsp. *assamensis.* Therefore it is likely that it is actually the female of *dubiosa,* notwithstanding the diversity of locality.

EPILACHNA DUBIOSA subsp. ASSAMENSIS, new subspecies

These specimens from Assam have the same structure as *E. dubiosa* including the male genitalia. However, the maculation is greatly modified in a manner very similar to that illustrated in figure 41 for *E. gangetica.*

Female genitalia (which are presumably identical with those of *E. dubiosa* s. str.).—Plates, length 0.66 mm. Shape approximately as shown in figure 190 (*wissmanni* Mulsant) but the outer apical margin more concave. The inner margin with a part cut out similar to

figure 190 but immediately (0.03 mm.) after the basal part of the cut-out is a tooth that divides the cut-out into a short basal and a longer apical part.

Maculation.—The pronotum is spotless. Elytral spot 1 very elongate along the suture and almost reaching the base. Spots 1+3+4+5+6 connected together as indicated in figure 41. Spot 2 not connected to No. 1 but joined by a narrow extension to No. 4. No. 6 does not reach the margin. Under side and appendages light, except the sides of metasternum, which are dark.

Material examined.—Type: U.S.N.M. No. 57121, India, Assam, Chabua, July 1943 (W. L. Jellison).

Paratype: Same locality, May 2, 1944 (D. E. Hardy, D).

15. EPILACHNA QUINTA, new species

Abdomen.—Abdominal lines incomplete, subterminal. Fifth segment, female, truncate with slight broad process in middle; sixth segment, split, apical angles distinct.

Female genitalia.—Plates, length 0.53 mm., greatest width 0.33 mm. Shape approximately that of figure 182 (*dentulata*), but the notch near the base of the inner edge more closed (as in figure 184).

Length.—7.0 mm. Shape broadly oval, convex; tips of elytra rounded.

Color and maculation.—Upper side red; pronotum with all seven spots present but of small size. Elytra each with six spots: No. 1 beginning well behind the scutellum, No. 4 not quite touching the margin. Under side light, except the tips of the mandibles and a spot in the apical corners of the metasternum dark.

Type.—U.S.N.M. No. 57964, from Ceylon (Koebele).

Remarks.—This species is in outward appearance so much like *E. dubiosa* that it was first believed to be a female specimen of that species. However, the female genitalia are distinctly different.

16. EPILACHNA OCELLATA Redtenbacher

FIGURES 38, 222

Epilachna ocellata REDTENBACHER, 1844, p. 563.
E[pilachna] oculea MULSANT, 1850, p. 791.

Abdomen.—Abdominal lines complete, subterminal, subangulate. Fifth segment, male, slightly concave; female, truncate. Pigment absent near middle of apex, giving appearance of a deep emargination. Sixth segment, male, emarginate, sometimes the coloration suggests

a longitudinal suture in the middle; female, split, apical angles of halves rounded.

Male genitalia.—Penis seen in profile, 1.35 mm. long, much wider than most other species of the genus, resembling the *enneasticta* group; greatest width 0.45 mm. about one-third from the base, then tapering off gradually except just before the apex, where it is bent up sharply into a sharp point. There are indications of a groove for the reception of the paramera. A sparse row of hairs on each side near the upper edge on the apical third but not on the part that is curved up. Seen from below, a tube for about one-fourth of its length, then opening up and trough-shaped becoming gradually narrower toward the apical point. It is completely closed for less than 0.05 mm. at the base and has beyond this a longitudinal slit 0.08 mm. wide, which becomes wider away from the base. Paramera 1.3 mm. long, spoon-shaped, with a strong emargination on the outside near the apex; the sides of the apical seventh sparsely, the apex itself more densely covered with light-colored hairs, about 0.15 mm. long. Sipho rather thick, about 0.2 mm. in middle, bent nearly in a semicircle near base, then bent outward through a right angle and from then straight to tip with diminished width; orifice oval on the elbow of the bend.

Female genitalia.—Genital plates, length 0.65 mm., greatest width 0.40 mm., upper part of side margin slightly emarginate, a definite rounded process at the basal part of the inner margin just before the feeble impression.

Length.—6 to 7 mm. Fine punctation of elytra obsolete; apical angle rounded.

Color and maculation.—Upper side dirty reddish brown, head lighter. Pronotum as in figures 4 I, J, or close to K. Elytra with six dark spots, each surrounded by a lighter halo. Common front tangent to No. 1 passing approximately through tip of scutellum. No. 4 widened laterally to margin. Pubescence dense, light gray, dark on the spots. Under side dark, prothorax, appendages, and epipleurae light. The latter with a spot not reaching the inner margin, corresponding to elytral spot No. 4.

Type locality.—India, Kashmir.

Material examined.—94 specimens. India: Kooloo, Ambala (N. M. Carleton, MCZ); Allahabad (through W. M. Mann, NM); United Prov., Kumayun, Bhawaki, 5,000 feet, June 18, 1944 (J. Unyal, D).

Remarks.—*E. ocellata* is easily separated from all the other species with 12 elytral spots by the structure of the abdomen, the ocellation of the elytra, and the genitalia, particularly those of the male, which

are quite different in structure from those of any of the preceding species and approach those of the *enneasticta* group. Mulsant and Mader state that this species is variable. The series I have seen is, however, uniform.

17. EPILACHNA TERTIA, new species

FIGURE 128

Abdomen.—Abdominal lines complete, reaching to within one-fifth of the hind margin of the first segment, fifth segment, male, hind margin mildly concave, sixth segment, emarginate.

Male genitalia.—Penis seen in profile, 1.75 mm. long, with rudimentary basal knife edge; rather wide (0.4 mm. at its widest part at about one-third of its length). Sparsely furnished with hairs (about 0.25 mm. long) on apical half. Seen from below, inner edges bent down, orifice very long (0.7 mm.). Paramera slender, slightly bent outward, 1.7 mm. long, with a slight apical thorn and with a ridge along their under side. Sipho with a constriction just before the tip and small oval orifice as indicated in fig. 128.

Length.—7 mm. Tips of elytra with indistinct angle.

Color and maculation.—Upper side brownish red, pronotum with black spots as in figure 4 in the type, spotless in the other specimen; elytra each with six dark spots, front tangent to No. 1 passing through tip of scutellum or a little more in front. Nos. 3 and 4 transversely widened, No. 4 almost touching the margin, the others roundish. Under side light, parts of metasternum darker. Pubescence whitish gray, dark on the spots.

Material examined.—Type: U.S.N.M. No. 57965, from India, Assam, Doom Dooma, May 20, 1943 (D. E. Hardy).

1 paratype (PA), India, northern Bengal, Kurseong, June (Mason collection). The dark spots in the paratype are brownish instead of black. This may be due to the immaturity of the specimen.

Remarks.—This is another one of the 12-spotted forms that cannot be referred to any of the previously described species. Its male genitalia are quite different from those of the majority of similar species. If the transversely widened shape of the middle spots is characteristic for the species, it should not be difficult to identify it by its external appearance.

18. EPILACHNA QUARTA, new species

Abdomen.—Abdominal lines subcomplete, subterminal, rounded at apex. Fifth segment, male, hind margin truncate or slightly concave. Sixth segment, emarginate.

Length.—6.5 mm. Tips of elytra rounded.

Color and maculation.—Upper side red. Pronotum with a central spot, as in figure 4 F, arising from the coalescence of spots 3+4+7. Spots 1 and 2 are faintly indicated besides. Elytra with all six dark spots joined together producing a pattern similar to figure 41 but with the black more extended. No. 1 begins at the tip of the scutellum, is on the suture, extends obliquely backward, and is broadly joined to No. 3. No. 2 on the callus has a triangular shape. One corner touches approximately the middle of the base, the second reaches the juncture of spots 1 and 3, the third extends faintly along the margin to the forward tip of spot 4. Spot 2 leaves the margin narrowly light. Spot 4 touches broadly the margin and is joined to No. 3. No. 5 touches the suture and is joined to 3 and 6. No. 6 is elongate, leaving the reflexed margin light. The pattern might also be regarded as five light spots on each elytron on a black background. Pubescence light gray all over. Under side and appendages light except the apical and side parts of metasternum and the central parts of the basal abdominal segments.

Type.—U.S.N.M. No. 57122, India, Assam, 10 miles north of Tinsukia, March 6, 1943 (D. E. Hardy).

Remarks.—This species has a modification of the 12-spotted pattern similar to that found in *E. gangetica connecta* and *E. dubiosa assamensis*. From both those species it is distinct by a different structure of the male genitalia. There are distinct differences in the spot patterns of the three species, but these are of doubtful value as long as nothing is known about the variability of the pattern in all three species. *E. quarta* can be separated from *dubiosa* by the fact that the sipho has the usual shape of figures 117 and 118. The tip is, however, more pointed than is indicated in figure 118, and the orifice is likewise pointed at its apex. From *gangetica connecta, quarta* can be distinguished easily by external characteristics. The pubescence is gray all over the elytra in *quarta,* but dark on the spots in *gangetica.* The tips of the elytra are rounded in *quarta* but distinct in *gangetica.*

Very likely *E. endomycina* Gorham, *andrewsi* Gorham, and *suspiciosa* Weise, all three from India, are related to these species.

19. EPILACHNA GANGETICA Weise

FIGURES 39, 40, 131, 188

E[pilachna] dorica MULSANT, 1850, p. 761.
Epilachna doryca var. *gangetica* WEISE, 1908, p. 218.

Abdomen.—Abdominal lines complete, subterminal, angulate. Fifth segment, male, hind margin truncate or slightly concave; female, truncate. Sixth segment, male, very slightly emarginate; female, split.

Male genitalia.—Very similar to those of *sparsa* Herbst. Penis seen in profile, somewhat more regularly curved, ending in a distinct hook. Basal knife edge long and wide. The emargination on the lower edge and the thickening on the upper edge just before the apex only very slightly indicated. Pubescence along the apical half. Seen from below, the part beyond the orifice not quite so narrow as in *sparsa* (0.07 as against 0.05 mm.). Paramera 1.8 mm. long with apical thorn. Sipho as in *sparsa.*

Female genitalia.—Genital plates, length 0.5 mm., greatest width 0.36 mm. Notch near base of the inner margin diamond-shaped. They differ from the genitalia of *sparsa* chiefly by the more pronounced notch; from those of *doryca* Boisduval by their greater width, their general shape, and the shape of the notch (see figs. 187 and 188).

Length.—6.5 to 7.0 mm. Tips of elytra with distinct angles.

Color and maculation.—Upper side red; pronotum with spots 1 to 4 or 1 to 6 (see fig. 4). Elytra each with six black spots. Nos. 1 and 5 close to the suture or actually touching it, No. 4 touching the margin. In the specimens with the least development of spots, Nos. 1, 2, 3, and 5 are subcircular, No. 2 smallest. No. 4 is widened laterally, No. 6 wedge-shaped with the thicker end toward the suture. In the darker specimens all spots, except 2, show a tendency to flow together in the direction of var. *connecta* apparently with all intergrades occurring. Under side light, most of metasternum and part of abdomen dark.

Type locality.—Southern India, Pondicherry.

Material examined.—4 specimens (MNH): Southern India, Coimbatoro District, Valparai, alt. 3,500 feet, July 7, September 3-15, 1937 (P. S. Nathan).

Remarks.—This species is very close to *sparsa* Herbst and would be difficult to separate from it by the genitalia, which are very similar. However, the tendency of the elytral spots to fuse in a very characteristic way makes it easy to recognize it. The separation from

doryca Boisduval, which particularly its darker forms (*connecta*) resemble, is probably safely made from the locality alone, as *doryca* is found only on New Guinea and vicinity. See also the remarks after *doryca*.

EPILACHNA GANGETICA var. CONNECTA, new variety

FIGURE 41

Differs from *gangetica* s. str. only in having all spots except No. 2 interconnected as indicated in figure 41. No. 6 often remains isolated. Pronotal spot 7 may be present in addition to the other ones. This variety resembles very closely the ground form of *doryca* Boisduval and often has been confused with it. The differences in the spot patterns of the two species as indicated by the differences between figures 41 and 42 are probably typical and would justify keeping the two species apart even without the differences in the genitalia.

Material examined.—Type: AMNH., Southern India, Coimbatoro District, Valparai, alt. 3,500 feet (P. S. Nathan).

3 paratypes: 1 from type locality; India, Madura District, Palni Hills, Kodaikanal, alt. 5,000-7,000 feet, June 1915 (L. V. Newton, PA); Madura (U.S.N.M. No. 57123).

20. EPILACHNA DORYCA (Boisduval)

FIGURES 42, 187

C[occinella] doryca BOISDUVAL, 1835, p. 597.
Epilachna doryca WEISE, 1902, p. 493; 1908, p. 218.

Abdomen.—Abdominal lines subcomplete, angulate, reaching to within about one-fourth (about 0.15 mm.) or less of the hind margin of the first segment. Fifth segment, male, hind margin truncate to slightly concave; female, truncate. Sixth segment, male, convex, very slightly emarginate; female, split. Tergite VIII of female with a distinct shallow notch in the middle of hind margin.

Male genitalia.—Very similar to those of *E. philippinensis* (fig. 118). Penis seen in profile, distinctly bent upward at about three-fourths of its length so that both upper and lower margin show this upward bend. Thickness very slightly increased just after the bend and then decreasing, ending in apical hook. Small basal knife edge. Two short rows of hairs 0.1 to 0.2 mm. long after bend on upper side; a few isolated longer hairs on basal end. Paramera with apical thorn, 1.5 mm. long. Sipho ends in sharp point as in *sparsa*.

Female genitalia.—Genital plates rather narrow, length 0.5 mm.,

greatest width 0.31 mm. The notches near base of inner margin subrectangular in shape.

Length.—5.8 to 7.0 mm. Apical angle of elytra distinct.

Color and maculation.—Upper side brownish red. Pronotum immaculate or with spots 1 to 4. Elytra in the typical specimens with points 1, 3, 4, 5, and 6 confluent so that the elytra have somewhat the appearance of a black background with four red spots, two on the suture, one humeral surrounding black spot 2, and one lateral. The last may be very small in dark specimens or even completely disappear (Weise, 1902, p. 493). One of the New Guinea specimens has the basal margin black so that spot 2 also is joined to the others. In addition the lateral margin is also black. Under side and appendages light with the metasternum more or less dark.

Type.—Paris Museum.

Type locality.—Dorei (northwestern New Guinea).

Remarks.—The maculation may be less connected than in the typical form, and there are specimens with six entirely unconnected spots on each elytron. All the partly connected forms belong to var. *erimensis.*

EPILACHNA DORYCA var. ERIMENSIS Weise

Epilachna doryca var. *erimensis* WEISE, 1902, p. 493.

Type locality.—Erima (on Astrolabe Bay, New Guinea).

Under this name Weise designated those forms of *Epilachna doryca* Boisduval in which elytral spots 1, 3, 4, 5, and 6 are not at all (rare) or only partly united. This variety is not sharply separated from the typical form, and intermediate forms occur. There is evidence that some of these have the character of subspecies. The specimens taken from one locality are all very similar among themselves but differ from those taken at different places. There seems to be a definite systematic change with the geographical location which would make the forms true subspecies, but there is not enough material to define the subspecies.

Material examined (*doryca* s. str. and var. *erimensis*).—37 specimens (NM, MCZ, AMNH, D), as follows:

4 typical specimens, New Guinea, New Britain.

18 specimens var. *erimensis,* Solomon Islands, Bougainville, July-September 1944 (A. B. Gurney), on eggplant in garden. One specimen with all spots free, the others with spots 1+3 or 1+3+4 connected.

7 specimens var. *erimensis,* Dutch New Guinea, Hollandia, Jan-

uary, April, May, 1945 (B. Malkin). Mostly 1+3+4 connected. Also 1+3+4, and 5+6, one specimen 3+4 only, one, 1+3+4+5.

8 specimens var. *erimensis,* Solomon Islands, Waimoni, San Cristoval (W. M. Mann); all these have only spots 1+3 connected.

Remarks.—There has been some confusion concerning *E. doryca* Boisduval and other related species. Boisduval (1835) described the species from Dorei, which is in the northwestern part of New Guinea. Mulsant (1850, p. 761) redescribed the species but took as typical specimens not Boisduval's type, which he saw in the Paris Museum, but specimens from the East Indies, which had all the dark spots separated. Gorham (1903) reiterated the statement that the specimens from India and New Guinea were indistinguishable, whereas Weise (1908, p. 218), on the contrary, recognized them as separate forms and called the Indian forms var. *gangetica,* which conception was taken over into the Korschefsky Catalog (1931, p. 28).

The genitalia of the New Guinea and Southwest Pacific forms, the true *doryca,* are quite distinctly different from the genitalia of the Indian specimens, so that the latter must be regarded as a separate species with the name *gangetica* Weise. *E. gangetica* Weise and *dorica* Mulsant are identical, but of course the latter name is preoccupied by *doryca* Boisduval.

The genitalia of *E. doryca* Boisduval are so similar to those of *E. philippinensis* that we may have to regard the latter as a subspecies of the former. However, the way in which the elytral spots coalesce allows us to keep the species apart. When in *philippinensis* and *p. remota* two spots coalesce we find invariably that the two coalescing spots are 3+4. In *E. doryca* when only two spots coalesce we find them to be 1+3, in darker specimens 1+3+4, then 1+3+4+5+6. The last is the typical form. However, two specimens from New Guinea were noted with only spots 3+4 united. This seems to strengthen the assumption that *doryca* and *philippinensis* are not distinct species. More material from the islands between New Guinea and the Philippines probably will clear up this problem.

21. EPILACHNA 11-VARIOLATA (Boisduval)

FIGURES 43, 44, 136, 183

C[*occinella*] *undecemvariolata* BOISDUVAL, 1835, p. 591.

Abdomen.—Abdominal lines complete, subangulate, reaching to within one-fourth of the hind margin of the first segment. Fifth segment, male and female, truncate. Sixth segment, male, hind margin convex, slightly emarginate; female, split.

Male genitalia.—Penis seen in profile, length 1.2 mm., lower edge straight for four-fifths of its length, then curved up; upper edge with distinct basal knife ridge, then curved in a gentle arc with concave side up. Apical point without hook, penis without hairs or with an occasional hair; paramera 1.1 mm. long, slightly wider and flattened toward apex, greatest width 0.15 mm., furnished on the rim of their apical third with a row of light blond hairs (about 0.2 mm. long). Sipho, tip rounded with an elongate orifice.

Female genitalia.—Genital plates, length, 0.40 mm., greatest width 0.25 mm., shape not very different from that of *28-punctata,* basal edge almost straight. Notch near base of inner edge narrow and deep, depth about 0.06 mm., very narrow at the edge, widening out into an oval shape.

Length.—5.6 to 5.8 mm. Tips of elytra rounded.

Color and maculation.—Upper side yellowish brown, pronotum often darker in the middle. Elytra with the six persistent spots relatively large, rounded, dark brown; No. 1 on the suture reaching in front to tip of scutellum, No. 5 touching or almost touching the suture, No. 4 somewhat laterally extended so that it reaches the margin. In addition, several of the nonpersistent spots occur apparently to somewhat variable extent.

The specimen from Malino has only *h* present, others *c,g,h1; c,d,g,h6; d,e,f,g,h,* up to all present except *a* and *b*. The nonpersistent spots are much smaller than the persistent ones. Under side and appendages light brown except sides of metasternum, which are dark, and the hind femora and base of abdomen, which are darkened in one specimen only.

Type locality.—New Guinea.

Material examined.—7 specimens, New Guinea, Hollandia, D.N.G., May 1945 (B. Malkin, NM, D); Celebes, Kawangosa, Malino (Brues, MCZ).

Remarks.—This species resembles superficially *26-punctata* or *28-punctata,* which occur in the same region. It can be separated easily by the genitalia, particularly those of the female, and it seems to be closer to *28-punctata* than to *26-punctata.* Unless a larger series would show an unusual variability, the spot pattern is sufficient for separating it from the neighboring species. The position of spots 1, *d,* 5, and *g* on the suture is a good characteristic.

22. EPILACHNA PYTHO Mulsant

FIGURES 45, 129, 185

E[pilachna] pytho MULSANT, 1850, p. 777.

Abdomen.—Abdominal lines complete, subterminal, subsymmetrical. Fifth segment, male, truncate; female, truncate. Sixth segment, male, mildly emarginate; female, split, apical corners rounded.

Male genitalia.—Penis seen in profile, with lower edge practically straight until about 0.15 mm. from end, where it curves gently up. There is a very feeble emargination just before that. Length 2.0 mm. No apical hook. Upper side with basal knife blade well developed and reaching to beyond about half the length. Upper edge a gentle arc. Apical half with hairs not longer than 0.2 mm. Paramera 1.9 mm. long, narrow, greatest width near apex 0.15 mm., in apical half higher than wide; hairs on rim of apical third about 0.2 mm. long. Apical thorn present. Penis tube 0.18 mm. wide, seen from below at apex of orifice about 0.08 mm. wide, subparallel until the upward bend. Sipho normal (compressed near tip).

Female genitalia.—Plates, greatest width 0.32 mm., length 0.53 mm. (Java specimen). Only very feebly emarginate on inner edge about one-third distance from base. The India specimen has shorter, the Borneo specimen longer, plates of about the same width and general shape.

Length.—6.2 to 7.0 mm. Shape subhemispherical, tips of elytra rounded or with an indistinct angle.

Color and maculation.—Upper side light brownish red. Elytra each with six spots. No. 1 with its counterpart forming one rounded spot bisected by the suture, partly or totally enveloping the scutellum. No. 5 also on suture. No. 4 reaching to margin. Under side light. Parts of metasternum and middle parts of abdomen dark (Java and India specimens); abdomen all light in the Borneo and Philippine specimens.

Type locality.—Java, Sumatra.

Material examined.—7 specimens (NM), as follows: 3 males, Philippine Islands, Mindanao, Dávao (Baker); Luzón, Paete.

4 females, Java, Buitenzorg, March 1909; Depok, 1909 (both Bryant and Palmer); India, Goa, Murmugao, June 1925 (J. C. Bridwell); Borneo, Sandakan (Baker).

Remarks.—There can be little doubt that this is Mulsant's *pytho,* although of course no absolute guarantee can be given that the males and females belong to the same species. They show no essential differences. The female genitalia of specimens from widely different

localities are somewhat different in proportion and may indicate several subspecies.

23. EPILACHNA PERPLEXA, new species

FIGURE 49

Abdomen.—Abdominal lines subcomplete, subterminal. Fifth segment, male, truncate to concave. Fifth segment, female, subtruncate with a slight process in the middle. Sixth segment, split, with the apical corners rounded.

Female genitalia.—Plates, 0.47 mm. long, greatest width (0.29 mm.) slightly beyond the middle; rounded at base and apex, inner edge nearly straight, with a very slight emargination at about two-fifths distance from the base.

Length.—6 to 6.5 mm. Apex of elytra rounded. Coarse and fine punctation of elytra both very distinct.

Color and maculation.—Upper side red. Pronotum with a discal spot, which is due to the confluence of spots 3+4+7 (fig. 4 F). Elytra each with six black spots, Nos. 1 and 5 on the suture, forming with their counterparts two common round spots, No. 1 partly enveloping the scutellum. No. 4 broadly touching the side margin, laterally widened and just touching No. 3 in one specimen. No. 3 subcircular. No. 6 also widened and touching the margin. Pubescence light gray, dark on the spots. Under side and appendages light, except most of metasternum, the middle of the basal part of abdomen, the epipleurae adjacent to spot 4, and the tips of the mandibles dark.

Material examined.—Type: U.S.N.M. No. 57124, Siam, at Karen settlement on headwaters of Me Ka, south of Moi Chiengda, March 16, 1937 (H. G. Deignan).

Paratype (D): India, Madura.

Remarks.—This species is very close to *pytho* Mulsant. The differences are chiefly in the greater extent of the black pigment on pronotum and elytra. The female genitalia in the two are similar, though there are differences in the exact shape of the plates and the shape of the emargination. In the absence of the male the exact status of *perplexa* will have to be left indefinite.

24. EPILACHNA PYTHARGA, new species

FIGURES 46, 186

Abdomen.—Abdominal lines complete, subterminal, subangulate. Fifth segment, female, truncate. Sixth segment, split, apical angles of parts distinct.

Female genitalia.—Plates, 0.43 mm. long, greatest width 0.28 mm. Shape oval. Notch near base of inner edge deep, widening away from the edge.

Length.—6 to 6.2 mm. Tips of elytra rounded or with indistinct angles.

Color and maculation.—Like *pytho* except that spot No. 5 only touches the suture and is not on it.

Material examined.—Type: U.S.N.M. No. 57125, Philippine Islands, Luzón, Mount Banájao (Baker).

2 paratypes (NM, D): One, same data as type; the other Luzón, Mount Maquíling (Baker).

Remarks.—This species resembles superficially *E. pytho* Mulsant. It is somewhat smaller, a little more elongate. It can be recognized by the fact that spot No. 5 does not form with its counterpart one spot bisected by the suture, as in *pytho,* but just touches the suture. The female genitalia of the two species (figs. 185 and 186) are quite distinct and will give a definite separation in cases of doubt.

There are several specimens from Mindanao, also females, which have a similar appearance and similar structure of the female genitalia but are considerably larger in size. In the absence of the males, it seems impossible to say whether they belong to the same or to a related species. They come from Dávao (Baker, NM) and Mount Apo, Galog River, 6,000 feet, November (C. F. Clagg, MCZ).

25. EPILACHNA HEMISPHERICA, new species

FIGURES 47, 130

Abdomen.—Abdominal lines complete, subterminal. Fifth segment, male, hind margin slightly concave; female, approximately straight. Sixth segment, male, truncate; female, split.

Male genitalia.—Penis seen in profile, about 1.7 mm. long, gently curved up in the middle on both upper and lower edges, sharply bent up just before the sharp apical point. Basal knife edge practically absent. Apical three-fifths clothed with long (about 0.5 mm.) and dense blond hairs. Seen from below, gently tapering from base to apex, about 0.27 mm. wide in middle; long, oval-shaped orifice. Paramera 1.7 mm. long, flattened and of almost uniform width (maximum 0.2 mm.). Apical thorn absent or only rudimentary. Apical three-fifths of rim sparsely and apex densely clothed with long hairs (about 0.4 mm. long). Sipho ending in straight point, orifice subterminal at side with liplike process (as in fig. 126).

Female genitalia.—Plates, 0.53 mm. long, 0.38 mm. wide; shape

almost rectangular with the basal side rounded off. A slight process on inner edge near base.

Length.—7 to 9.5 mm. Apical angles of elytra indistinct.

Color and maculation.—Upper side yellowish red to brick red. Pronotum spotless. Elytra each with six black spots, Nos. 1 and 5 on the suture, No. 4 touching the margin and reaching beyond the middle of the width of the epipleurae. No. 1 practically reaching the base and thus enveloping the scutellum, which remains light.

Material examined.—24 specimens (NM), as follows:

Type: U.S.N.M. No. 57126, from Philippine Islands, Luzón, Mount Maquíling (Baker).

17 paratypes from the type locality and the following other localities in the Philippine Islands: Luzón, Laguna Prov., Mount Banájao (Ube, Baker, McGregor); Majayjay, June 25, 1928, March 31, 1929 (McGregor); Tayabas Prov., Malinao (Baker); Lucbán, Tayabas (McGregor); Bho.

6 additional specimens: Mindanao Island, Dávao, Iligan, Surigao (all Baker).

26. EPILACHNA SIGNATIPENNIS (Boisduval)

FIGURES 50, 132, 184

C[occinella] signatipennis BOISDUVAL, 1835, p. 593.
E[pilachna] signatipennis MULSANT, 1850, p. 764.

Abdomen.—Abdominal lines complete, rounded, reaching to within one-third of hind margin of first segment. Fifth segment, male, hind margin truncate or slightly concave; female, with a very slight, broad process. Sixth segment, male, convex; female, split, with distinct apical angles.

Male genitalia.—Penis seen in profile, 1.1 mm. long, gently curved up, with sparse hairs (about 0.3 mm. long) even on basal part. Basal knife edge rudimentary. Seen from below, about 0.25 mm. wide, tube split open in middle with seams apart for most of the length. Triangular beyond orifice. Paramera 1.0 mm. long, slightly bent outward near base, then of almost uniform width (0.12 mm.) to apex, with small apical thorn; sparse pubescence on apical half. Sipho with tip strongly emarginate or bifurcate.

Female genitalia.—Plates, length 0.5 mm., greatest width 0.3 mm.; sides and base rounded. Notch near base of inner edge nearly a complete circle.

Length.—5.6 to 7.5 mm. Tips of elytra subrounded.

Color and maculation.—Upper side yellowish red to brick red.

Pronotum with the sides lighter, usually spotless, but occasionally with a median spot (3+4+7). Very dark specimens have most of the pronotum black except the sides. Elytra with six spots, which are partly confluent. In the lighter specimens only Nos. 3 and 4 united to form a transverse band, broadly touching the margin. Nos. 2 and 6 isolated, more or less rounded, No. 1 on the suture forming with its counterpart on the other elytron one rounded spot, which reaches forward to about the tip of the scutellum. No. 5 rounded, touching or almost touching the suture. Figure 50 shows an average specimen. In the darkest specimens, No. 1 extends to the base, No. 2 touches base and margin. No. 5 is also united with No. 4 and touches broadly the suture. Occasionally there is a narrow sutural margin left light. No. 6 has a tendency to touch Nos. 4 and 5. The apices of the elytra also may be dark (spot *h*) and this apical spot most often is connected with No. 6. Under side from almost completely light to almost completely black.

Type locality.—New Guinea and Waigiu Island.

Material examined.—133 specimens, New Guinea (G. Compere, NM; H. Edwards, AMNH), Stephansort, Mount Hagen, December 10, 1944 (D. G. Hall); New Britain, Mafor Island (also called Mefur or Numfor Island, lat. 1°S., long. 135°E. It is one of the group of Schouten Islands at the mouth of Geelvink Bay, northwestern New Guinea, which are also sometimes called Mysore Islands).

There is a good series (114 specimens) from Hollandia, Dutch New Guinea, January, May, 1945 (B. Malkin, NM, D).

There is not a great deal of variation in the spot pattern in this series, which is like figure 50, except that usually the apical spot *h* is present and united with No. 6. The pronotum is usually spotless but occasionally shows the discal spot faintly to distinctly (as in fig. 4 F). Its width is never more than one-fifth of the width of the pronotum.

Remarks.—*E. signatipennis* can easily be distinguished from other species either by the type of maculation or the male and female genitalia. Light specimens resemble some forms of *sparsa* but have spot 1 always on the suture. Dark specimens resemble superficially *solomonensis,* new.

27. EPILACHNA DIVERSA, new species

FIGURES 48, 134, 196

Abdomen.—Abdominal lines complete, subterminal, broadly rounded. Fifth segment, male, hind margin slightly concave; female,

truncate. Sixth segment, male, very slightly emarginate; female, split. apical corners narrowly rounded.

Male genitalia.—Penis seen in profile, from base to tip 1.1 mm. long, gently curved up until about 0.4 mm. from end, where it is bent suddenly almost 90°; and just before tip it is bent a little more. Upper side more uniformly curved until just before tip. Sparsely clothed with rather long hairs (about 0.35 mm.) on the basal two-thirds. Basal knife edge indistinct. Seen from below, rather broad, 0.4 mm. near base, slightly narrowing toward the orifice, which is at the bend. A longitudinal slit in the middle about 0.06 mm. wide at the base and gradually narrowing so that near two-thirds distance toward orifice the inner edges touch. Orifice rounded, about 0.16 mm. in diameter. Part beyond orifice a triangle 0.2 mm. long, base 0.15 mm. wide. Paramera 1.0 mm. long, subparallel 0.18 mm. wide, with apical thorn; apical half clothed with light blond hairs about 0.2 mm. long. Sipho long, shape of a question mark, orifice terminal.

Female genitalia.—Apical margin of tergite X convex; plates broad, length 0.42 mm., greatest width 0.45 mm. Emarginate at apical ends where stylus is attached. The notch near the base of inner edge hardly affects the dorsal side so that it appears as an oval depression on the ventral side.

Length.—6.2 to 7.0 mm. Tips of elytra rounded.

Color and maculation.—Upper side light reddish brown, head, pronotum, and scutellum black. Elytra each with six large black spots, making the distance between the spots much smaller than the diameter of the spots. No. 1 touching base and suture, No. 5 on the suture, No. 4 touching the margin. Under side black, mouth parts, antennae, tarsi, epipleurae, and tips of femora and tibiae light.

Material examined.—Type: U.S.N.M. No. 57127, Philippine Islands, Luzón (R. C. McGregor).

Paratype: Luzón, Benguet Prov., Baguio (Baker).

Remarks.—This species is easily recognized by its external appearance. Its genitalia are also distinctive and considerably different from the usual type of this group.

EPILACHNA DIVERSA subsp. TAYABASA, new subspecies

This subspecies is based on a specimen with the same structure of the genitalia as *diversa* s. str. It differs by the coloration and maculation, upper side light brownish red, head and pronotum completely light. Elytral spots much smaller than in *diversa* s. str., all more or less rounded, No. 4 touching the margin broadly, No. 5 just touching the suture.

Type.—U.S.N.M. No. 57966, from Philippine Islands, Tayabas, Malínao (Baker).

28. EPILACHNA BOISDUVALI Mulsant

FIGURES 51, 52, 135, 198

E[pilachna] Boisduvali MULSANT, 1850, p. 765.

Abdomen.—Abdominal lines subterminal, complete, and forming a regular arc. Fifth segment in both sexes subtruncate to slightly concave. Sixth segment, male, subtruncate with a slight emargination; female, split.

Male genitalia.—Penis seen in profile, a straight, slightly tapering, approximately parallel tube for nearly three-fourths of its length, then bent upward, and bent a little more just before the apex which is a point, with two rows of sparse hairs on the middle half. Seen from below, tube closed for about 0.9 to 1.0 mm., then opening, the sides of the orifice with rounded edges; about 0.2 mm. wide in middle. Paramera 1.1 mm. long with small apical thorn; greatest width inside near rim 0.2 mm., rim covered with hairs on apical half. Sipho with bifurcate tip.

Female genitalia.—Plates, oval with convex inside edge; length 0.58 mm., greatest width 0.48 mm. Tenth tergite with emargination at apex, strip along each side with brown pigment, middle clear.

Length.—7 to 7.6 mm. Tips of elytra rounded.

Color and maculation.—Upper side yellowish red. Pronotum in the Australian specimens with a central spot, which in lighter specimens can be seen to originate from the confluence and expansion of the spots 3, 4, and 7. The Philippine specimens have the pronotum spotless or the spots only very faintly indicated. Elytra each with six spots. Nos. 1, 3, and 5 have usually approximately the same distance from the suture. However, in some Philippine specimens, No. 3 is definitely farther from the suture than 1 and 5 (fig. 51). Tangent to No. 1 goes about through tip of scutellum or a little in front of it. No. 4 transversely widened and linked with margin. Under side light, the sides of the metasternum and often the whole metasternum and part of the abdomen darker.

Type locality.—Australia (?).

Material examined.—12 specimens, as follows:

Australia: Queensland, Cairns, Babinda, October 1920 (J. F. Illingworth, BBM).

Philippine Islands: Luzón, Bataan Prov., Mount Banájao (Baker); Mount Maquíling (Baker); Limay, San Andales; Mindanao Island.

Bukidnon Prov., Tangcolan (Baker, NM); Dávao (C. S. Banks, MCZ); Tayabas Island, Lucbán, May 1926 (McGregor, NM); Leyte Island, Jaro, October 1915 (MCZ).

Sumatra: Pagacamba (C. T. and B. B. Brues, MCZ), large elytral spots; disk of pronotum dark.

Remarks.—The Philippine specimens agree very well with the description and figure of *E. nativitatis* Arrow (1900) from Christmas Island. As there are only very few species with the third spot not much farther from the suture than the first and fifth, the probability is very great that *nativitatis* Arrow is identical with *boisduvali* Mulsant. The only difference between the Australian and Philippine specimens seems to be the absence of the pronotal spot in the latter, which is too insignificant even to consider them a separate subspecies. Should this difference, however, be consistent and the identity with Arrow's species be confirmed, the Philippine and Christmas Island specimens might be separated from the Australian ones as subsp. *nativitatis* Arrow.

EPILACHNA BOISDUVALI subsp. CHABUANA, new subspecies

A pair of specimens of *Epilachna boisduvali* from Assam, India, are sufficiently remote from the typical form to deserve to be classified at least provisionally as a new subspecies.

Both male and female genitalia are indistinguishable in structure from those of the typical *boisduvali.* In appearance the Assam specimens present the following differences: Size smaller (length 5.5 to 6.0 mm. as against 7 to 7.6 mm. of the typical form), elytral spots relatively smaller. Pronotum of the female with four large not very distinct spots arranged in a transverse row. The individual spots cover longitudinally about the central two-thirds. Color darker, which may, however, be due to the method of preservation.

Type.—U.S.N.M. No. 57128, India, Assam, Chabua, April 20, 1943 (D. E. Hardy). One paratype, same data.

Remarks.—These two specimens are of great interest, as they show that *E. boisduvali* is a very widespread species, ranging from northern India to the Fiji and Samoa Islands. The female specimen is so far the only example in which the arrangement of spots on the pronotum does not fit into the standard pattern of figure 4. It resembles much more the pattern of *Afidenta mimetica.*

EPILACHNA BOISDUVALI subsp. FIJIENSIS Crotch

FIGURE 53

Epilachna Montrouzieri var. *fijiensis* CROTCH, 1874, p. 89.

This form differs from the typical specimens only in a somewhat larger size and an enlargement of the elytral spots. No. 3 is subwedged-shaped, with the narrow end toward the suture, and No. 5 is triangular, with the base parallel to the suture. Also the pronotal spot is more developed.

Material examined.—5 specimens, as follows:

Fiji Islands: Ovalau Island, Levula (Abbott, MCZ); Thawati, July 12, 1938; Viti Levu Island, near Nandarivatu, 2,500 feet, September 15, 1938 (E. C. Zimmermann, BBM).

New Hebrides: Espiritu Santo Island, September 1944 (K. L. Knight, NM). This specimen is different from the Fiji specimens in that spots 3 and 4 are joined to form an oblique fascia which does not reach the suture. It may be the representative of a new subspecies.

EPILACHNA BOISDUVALI subsp. SAMOANA, new subspecies

FIGURE 54

Only one female of this form is available. Except for the elytral pattern, it resembles *E. boisduvali* in practically all respects, including the female genitalia. It is therefore likely that this form is a subspecies or perhaps even only a variety of *E. boisduvali*. The elytral spots tend to be longitudinally enlarged in contrast with the trend to transversal enlargement present in *boisduvali* s. str. and its subspecies *fijiensis,* and this would ordinarily suggest a separate species. In the absence of more material, particularly males, no definite decision can be reached.

Color and maculation.—Upper side reddish yellow; pronotum with a basal dark spot, which represents the coalescence of the usual spots 3, 4, and 7. Elytra with the dark spots more or less longitudinally elongated. This is most evident in Nos. 2 and 5, least in 1 and 4. In the latter a tendency to lateral dilatation toward the margin is apparent. Spot 3 is considerably farther away from the suture than Nos. 1 and 5. Nos. 3 and 5 touch.

Type.—Female, Samoa Islands, Tutuila, Vaitogi, February 1930 (D. T. Fullaway, BBM).

29. EPILACHNA MOULTONI subsp. MANUSENSIS Korschefsky

Epilachna moultoni subsp. *manusensis* Korschefsky, 1933a, p. 236.

Abdomen.—Abdominal lines complete, subterminal, inner edge broadly rounded, outer one straight. Fifth segment, hind margin truncate or slightly concave. Sixth segment, male, hind margin concave; female, split, apices with rounded angles.

Male genitalia.—Very similar to those of *E. boisduvali* (fig. 135) with no significant differences.

Female genitalia.—Of the same general shape as those of *E. boisduvali* Mulsant (fig. 198). Length 0.56 mm., greatest width 0.50 mm. There is a sharp narrow transverse depression near the base of the inner edge which seems more indistinct in *boisduvali.* Tergite X with pigment divided on a strip on each side.

Length.—6 to 7 mm. Tips of elytra rounded.

Color and maculation.—Upper side yellowish red. Pronotum spotless. Elytra each with the following black spots: Nos. 1 and 2 united into one broad spot reaching from near the suture to the callus and touching the base in the darker specimens, but not the side margin; scutellum left light; No. 3 small; No. 4 broadened and reaching to the middle of the epipleurae; No. 5 on the suture; No. 6 rounded and relatively smaller. Spot 3 separate in the lighter specimens, joined to No. 4 and No. 5 in the darker ones. Pubescence yellowish, dark on the spots. Under side and appendages light except for tips of mandibles, parts of mesosternum and metasternum, and the middle of the abdominal segments, which are often dark.

Type.—Museum Bremen and Korschefsky collection.

Type locality.—Admiralty Islands, Station Manus.

Material examined.—9 specimens (NM, D): Admiralty Islands, December 23, 1944 (P. T. Riberd).

Remarks.—The differences in structure between *E. moultoni manusensis* and *boisduvali* are so slight that eventually *moultoni* may turn out to be a subspecies of *boisduvali.* The confluence of spots 1 and 2 permits an easy identification of *moultoni.*

EPILACHNA MOULTONI subsp. MOULTONI Crotch

Epilachna Moultoni Crotch, 1874, p. 89.

Three specimens of *moultoni* probably belong to the typical form, although two of them would have to be classed under subspecies *manusensis* Korschefsky if the author's definition of this subspecies is accepted.

Korschefsky classified all specimens with spot 3 completely missing as *moultoni moultoni* Crotch, whereas all the forms with spot 3 present were called by him subsp. *manusensis*. In subsp. *manusensis*, spots 3, 4, and 5 may be partly or completely united.

The three specimens from the Solomon Islands differ from those from the Admiralty Islands listed under subspecies *manusensis* Korschefsky by their larger size (length 8 mm.), by the fact that the apex of the abdominal lines is more rounded, and by the smaller size or absence of spot 3. Even though spot 3 is present in the specimens from Guadalcanal, they resemble so much in general appearance the specimen from San Cristoval, which conforms entirely to Crotch's description, that they must be considered as belonging to *moultoni* s. str. Unfortunately, Crotch does not mention the size of *E. moultoni* in the original description.

Type locality.—New Caledonia.

Material examined.—3 specimens, all females, from Solomon Islands: San Cristoval, Pamua (W. M. Mann, MCZ), spot 3 missing completely, 4 large, 5 and 6 small; Guadalcanal, August 15, 1943 (P. W. Oman, NM), spot 3 present, small, spot 4 touching the suture.

30. EPILACHNA BAGUIANA, new species

FIGURES 55, 133, 192

Abdomen.—Abdominal lines entire, subterminal, subangulate. Fifth segment in both sexes with hind margin subtruncate. Sixth segment, male, hind margin convex, slightly flattened; female, split.

Male genitalia.—Smaller than in most other species. Penis seen in profile, 0.95 mm. long, only a rudimentary basal knife edge; upper edge curved almost from the base in a wide arc concave side up, point without hook, hairs on basal half. Seen from below, tube narrowing regularly from base to apex, closed part short, about 0.35 mm. long; orifice ovaloid, about 0.35 mm. long. Paramera 0.9 mm. long, slightly bent outward near base, from then on flattened with parallel sides 0.15 mm. wide. Rim of apical third with light blond hairs (about 0.2 mm. long). Sipho with tip rounded, orifice oval.

Female genitalia.—General shape and size as in *E. sparsa* and allied species. A triangular notch on the basal half of the inner edge distinguishes *baguiana* from all other known species.

Length.—7 to 8 mm. Sutural angles of elytra subdistinct.

Color and maculation.—Upper side brownish or yellowish red. Pronotum with all seven black spots (fig. 4 G), No. 7 small or often

absent, 1 and 5 (resp. 2 and 6) confluent. Elytra each with six large spots, No. 3 not appreciably farther from the suture than 1 and 5. The dimensions of the spots much larger than the distance between them, No. 1 smallest, 4 not touching the margin. Under side mostly dark, except prothorax and the two last sternites. Epipleurae and appendages, except tip of mandibles, light. Femora with elongate dark spots in middle.

Material examined.—Type: U.S.N.M. No. 57129, Philippine Islands, Luzón Island, Baguio, Benguet (Baker).

4 paratypes (NM): Same locality (G. G. Haslam, Baker).

One additional specimen: Mindanao Island, Zamboanga (MCZ).

Remarks.—This species is well characterized by its spot pattern and its male and female genitalia, and so confusion with any other species is not likely.

31. EPILACHNA SEXTA, new species

FIGURE 219

Abdomen.—Abdominal lines complete, subterminal, subangular, outside edge straight. Fifth segment, male, hind margin straight or slightly concave; female, slightly convex. Sixth segment, male, emarginate; female, split, tips rounded.

Male genitalia.—Penis seen in profile, 1.5 mm. long, only trace of basal knife edge; widest at base, nearly straight for basal two-thirds, upper edge then curved to the apical point, which points straight up; lower edge bent at two-thirds of its length and straight again until before the apex where it is bent up through practically 90°, covered with hairs (0.4 to 0.5 mm. long) on its middle portion. Seen from below, tube widest at base and becoming narrower toward orifice, which is elongate; width at center of orifice about 0.15 mm.; part beyond orifice narrow, about 0.03 mm. wide, subparallel but slightly widening toward apex. Length from orifice to apex about 0.3 mm. Paramera 1.5 mm. long, greatest width (near apex) 0.15 mm., slightly curved outward, with blunt apical thorn; rim of apex and apical half of outside covered with blond hairs. Sipho, regular shape (fig. 117), orifice oval, subterminal; apical 0.4 mm. compressed.

Female genitalia.—Plates, 0.65 mm. long, greatest width 0.40 mm.; shape roughly that of figure 186. On the inside edge about one-third from base a strong depression, tergite X pointed.

Length.—0.65 to 0.85 mm. Tips of elytra rounded.

Color and maculation.—Upper side light brownish red, head and pronotum spotless. Elytra with six black spots. Nos. 1 and 5 on

the suture in the darker specimens, not quite reaching the suture in the lighter ones. No. 2 rounded, No. 4 broadly on the margin in the darker specimens, just reaching the margin in the lighter ones. Under side light except tips of mandibles, part of metasternum and the middle part of the first four abdominal segments, which are dark. In the lighter specimens abdomen completely light.

Material examined.—Type: Museum of Comparative Zoology, from Celebes, Molino (Brues).

6 paratypes (MCZ, D, all Brues) from the type locality and from Celebes, Langsa (one marked July 1937).

Remarks.—This is another one of the 12-spotted species that are practically unseparable from related species except by their genitalia.

32. EPILACHNA LIBERA, new species

FIGURES 59, 60, 138

Abdomen.—Abdominal lines complete, rounded, reaching to within one-fifth of the hind margin of the first segment. Fifth segment, male, truncate; female, slightly convex. Sixth segment, male, convex; female, split, apices rectangular.

Male genitalia.—(Inasmuch as the only male specimen is apparently a somewhat distorted immature specimen, the actual shape of the undistorted genitalia might be slightly different.) Pénis seen in profile, 1.7 mm. long. Basal knife edge present. Lower edge straight until shortly before apex, where it is strongly curved up through about 90°. A slight emargination just before this bend and a slight bulge on the corresponding part of the upper edge. From two-fifths to four-fifths of its length the upper edge densely covered with two rows of long (0.6 mm.) light blond hairs. Penis seen from below, tube with elongate orifice without definite front margin. The part beyond the orifice long (0.5 mm. or longer), constricted immediately beyond orifice, then widened again to about 0.1 mm. and then gradually narrowing to a blunt point. Paramera 1.6 mm. long, widened toward apex (maximum width 0.2 mm.), densely covered with rather long hair. Sipho with orifice small, terminal.

Female genitalia.—Genital plates, length 0.60 mm., greatest width 0.36 mm., shape like *28-punctata*. Notch near base of inner edge transversely oval, not cut all the way through; edges of the notch darkened.

Length.—8 to 8.5 mm. Tips of elytra with angles distinct.

Color and maculation.—Upper side brownish red. Pronotum with

hazy dark spots, the lateral ones, Nos. 1 and 5, better developed than the central ones. Elytra with the persistent spots large and often united. No. 1, on the suture, triangular, enveloping the scutellum. Nos. 3 and 4 united in all three specimens, No. 5 rounded, practically touching the suture; No. 6 laterally widened, slightly bent, with concave side to rear. Spots 2, 4, and 6 practically touch the margin and leave only the narrow reflexed part light. Spots 1 and 2 may be united, forming a broad fascia with a light spot on each side of the scutellum enclosed, spots 4+3+5 are completely united in two of the specimens. In addition to these persistent spots, several of the nonpersistent spots may also be present: $d+e$ and $g+h$. In one specimen e is united with $g+h$. Pubescence light gray all over. Under side and appendages light, metasternum black, basal part of abdomen and sometimes other parts of under side dark.

Material examined.—Type: U.S.N.M. No. 57130, China; Szechwan Prov., Kuanhsien to Uen Chuan, July 4-7, 1924 (D. C. Graham).

2 paratypes: Shin Kai Si, Mount Omei near Kiating, alt. 4,400 feet, 1921; and near Kuanhsien, alt. 2,000-4,000 feet, August 1933 (D. C. Graham, NM).

Remarks.—This species is easily recognized by its maculation, which does not coalesce in this particular way in any other species known to me, by the uniformly light gray pubescence also in the black spots (this is shared by some other forms, such as *sparsa* and *niponica*, occurring in the same territory), and particularly by the structure of the male genitalia.

33. EPILACHNA DELESSERTII (Guérin)

FIGURES 58, 137

Coccinella (epilachna) Delessertii GUÉRIN, 1840, p. 42.
E[pilachna] Delessertii MULSANT, 1850, p. 747.

Abdomen.—Abdominal lines complete in the two females; incomplete, reaching only to the hind margin of the first segment in the male; subterminal. Fifth segment, male, slightly concave; female, truncate with depression in the middle. Sixth segment, male, emarginate; female, split, apical corners rounded.

Male genitalia.—Penis seen in profile, with a distinct bend at about two-thirds of its length, this bend more distinct on the under side than on the upper side; bent again about 0.2 mm. before the end, without, however, forming a definite hook. No basal knife edge, sparsely pubescent between the two bends. Seen from below, orifice elongate with pointed apical margin at about the position of apical

bend. Paramera 1.5 mm. long, gradually widening toward apex and slightly bent down on apical third; greatest width about 0.14 mm., no apical thorn; pubescence on apical third rather short. Sipho, bent mildly at about one-third of its length, bent outward about 0.35 mm. from end. Orifice small, oval, about in the middle of the side of this last part.

Female genitalia.—Plates rounded at basal end, more or less truncate at apical end. No notch on inside edge.

Length.—7 to 8.5 mm. Elytra prominently margined, a subapical depression near the margin which makes the reflexed part very wide there. Tips of elytra rounded.

Color and maculation.—Upper side brownish red. The elytra with all the spots interconnected so that a grating results that can best be described by considering the ground color of the elytra black, each with five large red spots 2, 2, 1, the first four touching neither suture nor margin, the fifth apical. Under side light, metasternum, part of mesosternum and prosternum, and abdomen, except its sides, dark. Epipleurae partly dark.

Type locality.—East Indies, Plateau of Nilgherry.

Material examined.—3 specimens: India: Madura district, Kodaikanal. Palni Hills, alt. 5,000-7,000 feet, June 1915 (L. V. Newton, C. Leigh, PA); Trichinopoli.

Remarks.—The difference in the abdominal lines between male and female is peculiar and rather pronounced. Since the specimens are alike in all other respects, it is reasonably sure that they belong to the same species. Whether this is really a sexual difference or an accidental variation only more material can decide.

34. EPILACHNA SOLOMONENSIS, new species

FIGURES 61, 139

Abdomen.—Abdominal lines complete, subterminal, somewhat flattened at apex. Fifth segment, male, hind margin mildly concave; female, truncate. Sixth segment, male, subtruncate; female, split.

Male genitalia.—Both male and female genitalia very much like those of *E. 28-punctata* (Fabricius). There are differences, but they would come out only in an actual comparison of the specimens. Penis seen in profile, 1.4 mm. long, gently curved toward apex and ending in sharp point. Small but distinct basal knife edge. Penis with sparse hairs on most of its upper side. Seen from below, the usual tube, orifice with oval apex; at the apex of the orifice the penis is 0.13 mm. wide, distinctly wider than for *28-punctata* (which has there only a

width of 0.09 mm.). Paramera 1.4 mm. long, about constant width (0.1 mm.), somewhat narrower just before apex; apical thorn present, rim of apical half with hairs (about 0.2 mm. long). Sipho, tip with the same kind of notch as in *28-punctata.*

Female genitalia.—Very similar to figure 182.

Length.—7.5 mm. Tips of elytra rounded.

Color and maculation.—Upper side red, pronotum spotless, elytra with a basal fascia consisting of spots 1 and 2, extended farther back at the suture; scutellum light, sometimes with a dark border. Spots 4+3+5 form a discal fascia bent back in form of a V near the suture. Spot 6 widened and touching the margin. Pubescence short, blond; black on the dark spots. Under side and appendages light, except tip of mandibles, metasternum, and outer parts of epipleurae where the spots reach them.

Material examined.—Type: U.S.N.M. No. 57131, Fulakora, Solomon Islands (Ch. Bignell).

5 paratypes: Solomon Islands, Guadalcanal Island, July 1927 (AMNH), 1920 (J. A. Kusche, BBM); Bougainville, July-September 1944 (A. B. Gurney, D).

Remarks.—This species is in all its morphological characters very close to *28-punctata* Fabricius, particularly the notched apex of the sipho, which has not been observed in any other species. However, the type of maculation immediately distinguishes the species.

There is superficial resemblance to *E. guttatopustulata tricincta* Montrouzier, and the specimens were found labeled as such in one of the collections. The two species can, of course, immediately be separated by the genitalia. Actually, however, the superficial appearance is sufficient to keep them apart. *E. solomonensis* is less elongate and more convex than *tricincta.* Furthermore, in *tricincta* the discal fascia does not have the V-shaped bend near the suture and is besides narrowly interrupted by the suture. The apical spot is in the apical angle of the elytra, whereas in *solomonensis* it is definitely removed from it. Finally, the part near the margin between the two fasciae is usually considerably lighter than the rest of the elytra in *tricincta,* as it is the remnant of the yellow spot in *guttatopustulata. Epilachna parafasciata,* the only other species of *Epilachna* with unquestionable fasciae, does not have the V-shaped bend of the discal fascia and besides has a different geographical distribution.

35. EPILACHNA PARAFASCIATA, new species

FIGURES 62, 221

Abdomen.—Abdominal plates complete, reaching to within one-third of apical margin of first segment. Fifth segment, male, truncate or slightly concave; female, truncate with a rounded process in middle. Sixth segment, male, emarginate; female, split, corners distinct.

Male genitalia (fig. 221).—Very similar to those of *E. sparsa* and *E. gangetica.* Penis seen in profile, 1.60 mm. long, with distinct basal knife edge and apical hook; apical half slenderer than in *sparsa* or *gangetica* and without a distinct bulge as in *sparsa* and not wedge-shaped as in *gangetica;* pubescence about 0.2 to 0.3 mm. long on apical third. Seen from below, wider than in *sparsa* and *gangetica,* about 0.2 mm. at the orifice, wedge-shaped from there to apex. This last is the most easily detected difference from *sparsa* and *gangetica.* Paramera 1.6 mm. long, with apical thorn. Sipho as in *sparsa.*

Female genitalia.—Plates, length 0.60 mm., greatest width 0.37 mm., shape normal. Notch near base of inner edge with rounded edges cut in much farther on the under side than on the upper side; axis pointing toward base.

Length.—7 to 7.6 mm. Tips of elytra with distinct angle.

Color and maculation.—Upper side light brownish red; head and pronotum spotless; elytra with two transverse fasciae and an apical spot (No. 6), which is widened and touches the margin. The first fascia touching the base, but not quite reaching the side margin and leaving the scutellum light; wider at the suture, but only slightly so, not suddenly widened there. Discal fascia almost straight from margin to margin. Somewhat constricted about one-third distance from the margin (indicating the separation of spots 3 and 4), the front margin practically going straight across the suture. Under side and appendages light, mesosternum and metasternum, the middle of the first four abdominal segments, and the epipleurae where the middle fascia reaches them, dark.

Material examined.—Type: U.S.N.M. No. 57132, from Java, Tjibodas, Mount Gede, alt. 9,500 feet, April 1909 (Bryant and Palmer).

7 paratypes (NM, MCZ, D): two from type locality (alt. not given); one from Buitenzorg, Java, March 1909 (Bryant and Palmer); four from Tjiboda (T. Barbour).

Remarks.—This species, although very similar to others in structural characteristics, can be easily recognized by its external appearance. The eight available specimens show no appreciable variation,

and there is no known *Epilachna* species with which it can be confused even with a superficial inspection. It is, however, very similar in appearance to *Afissa orthofasciata,* from which it can easily be separated by the generic characters and the genitalia.

36. EPILACHNA HAEMORRHOA Boisduval

FIGURES 63, 64, 140, 194

C[occinella] haemorrhoa BOISDUVAL, 1835, p. 599.

Abdomen.—Abdominal lines complete, reaching to within one-fourth of the hind margin of the first segment. Fifth segment, male, hind margin truncate or slightly concave; female, with a longitudinal ridge in the middle of apical half, hind margin subtruncate. Sixth segment, male, hind margin, convex; female, split, each half rounded.

Male genitalia.—Penis seen in profile, 1.43 mm. long, no basal knife edge, wide at base, then becoming much narrower and curved up in a gentle arc. Sparsely covered with hairs (about 0.2 mm. long) where it becomes narrower. Seen from below, with elongately diamond-shaped orifice with the sides rounded. Width of penis at widest part of orifice 0.16 mm., at apex of orifice 0.10 mm., part beyond orifice about 0.33 mm. long gradually tapering to point and curved up. Paramera 1.3 mm. long, seen from above gently curved outward, slender, widest (0.13 mm.) near apex, without apical thorn, with rather short hairs on apical part. Sipho, normal shape, compressed laterally at apex, orifice oval, subterminal on side.

Female genitalia.—Plates together heart-shaped with heart-shaped notch near base of inner edge. In general, shape of genitalia similar to those of *signatipennis* Boisduval.

Length.—5 to 7.5 mm. Apical angle of elytra slightly protruding inward. Basal tooth of claws triangular; epipleurae reaching practically to apex, hollowed in front half.

Color and maculation.—Upper side, head, scutellum, and pronotum reddish brown, sides of latter yellowish; elytra dark brown or black with a common apical red spot. This spot covers about one-fourth to one-third of the length, has its front margin arched, and usually reaches less far forward at the suture than at the margin. Hairs on elytra uniformly light gray. Under side, in the lighter specimens mostly light brown, with metasternum, hind tibiae and most of the epipleurae dark. In the darker specimens the dark color spreads so that only the mouth parts, the prothorax, the sides of the basal four abdominal segments, and the entire fifth and sixth remain light. The legs in such dark specimens are black, except the front femora ex-

clusive of their tips and small spots at the base of the middle and hind femora, which remain light.[15] (The specimens from Mount Misum, New Guinea, are of this kind. The red apical spot of the elytra may be reduced then to a very small size.)

Type.—Paris Museum.

Type locality.—Dorei, northwestern New Guinea.

Material examined.—11 specimens: New Guinea, Finschhafen (NM, D); Mount Misum, Morobe Distr. (MCZ).

Remarks.—The male genitalia of this species are very similar to those of *E. mjoebergi* and *E. mindanaonis.* It differs from these species by the type of maculation and from the latter also by the female genitalia.

EPILACHNA HAEMORRHOA HOLLANDIAE, new subspecies

There is a good series from Hollandia, Dutch New Guinea, which although showing considerable variation is lighter than any of typical specimens from farther west (type locality) or farther east (Finschhafen). The male and female genitalia show no significant differences. The average size is smaller. It seems justified to consider these forms as a separate subspecies.

The darkest *hollandiae* specimens have besides the apical red spot, which occupies about the apical third of the elytra, a humeral spot extending backward to about one-third of the length of the elytra and inward about one-half of their width. It is directed slightly inward so that the margin behind the shoulder remains dark. The under side is entirely light, with only small traces of dark left.

Most specimens of the series have elytra with the light coloring more extended. Progressively the entire front margin becomes light, then also a narrow longitudinal strip at the suture from a little behind the scutellum to somewhat in front of the apical spot. If the red is even more extended the ground color of the elytra appears red with a few dark spots. In that case the humeral spot is united with the apical one so that the pattern consists of a marginal spot at about the middle of the margin and a longitudinal elongated spot reaching from the scutellum to the suture behind the middle but leaving the middle of the suture red. This longitudinal spot is then broken up into two or three, one, the largest, on the disk on the suture

[15] The coloration of these specimens is what Weise (1903, p. 229) describes as typical for *E. fulvimana* Weise, which may therefore be identical with *haemorrhoa* Boisduval, as the other distinguishing characters are all rather vague. The type locality of *E. fulvimana* is New Guinea, Huon Gulf, Saddle Mountain, Simbang.

behind the middle, and a smaller one immediately behind the scutellum. If the scutellar dark spot is absent we have what Weise described as var. *dissoluta* (Weise, 1902, p. 491).

The lightest specimen from Hollandia I have seen has no trace of the dark coloration left.

Material examined.—Type: U.S.N.M. No. 57967, from Hollandia, Dutch New Guinea. 84 paratypes from the same locality, January, April, May, 1945 (B. Malkin, NM, D).

Remarks.—It will be interesting to see whether the transition to the typical form is gradual.[16]

37. EPILACHNA MJOEBERGI Weise

FIGURES 66, 142

Epilachna Mjoebergi WEISE, 1923a, p. 131.

Abdomen.—Abdominal lines complete, reaching to within one-fourth of the apical margin of the first segment. Fifth segment, male, truncate to slightly concave. Sixth segment, slightly emarginate.

Male genitalia.—Penis seen in profile, 1.6 mm. long, with distinct

[16] From New Guinea and the neighboring islands a number of species have been described having the elytra dark with one or more reddish spots. Many of the descriptions are such that the species cannot be recognized from them. Some of these species also have lighter forms, for which the ground color of the elytra is red. On the whole these species do not form a very homogeneous group, and characters can be found by which they can be separated. A few notes about these species may be helpful. Type locality is New Guinea unless differently indicated.

E. haemorrhoa Boisduval: See p. 90.

E. fulvimana Weise: Very probably a dark form of *haemorrhoa.* See p. 91.

E. kampeni Weise: Possibly a variety of *haemorrhoa.*

E. antiqua Weise: Ranges from a light form with the six normal dark spots to a form with practically completely black elytra.

E. biroi Weise: See p. 106.

E. cirunigra, new: See p. 107. Close to *biroi,* but pubescence black on black parts of elytra, while it is gray in *biroi.*

E. haematomelas Boisduval: Claws without tooth, elytra with a shoulder and apical spot.

E. malkini, new: Claws like *haematomelas,* but smaller. Only subapical red spot present. See p. 108.

E. papuensis Crotch: Might be identical with *malkini.*

E. aruensis Crotch: Aru. "Elytra with two rounded yellow spots, one basal and one subapical, neither reaching the margin."

E. sobrina Harold: Salwatty. "Almost exactly like *E. aruensis* in coloration but hemispherical, more pubescent, and with the apical spot much smaller."

basal knife edge, which reaches practically to middle. Apical bend uniform through about 90°. No apical hook. Sparsely pubescent on basal two-thirds. Seen from below, orifice very elongate, width of penis at apex of orifice 0.1 mm., length beyond it 0.33 mm., gradually tapering to point. Paramera 1.65 mm. long, very gently bent outward near base, gradually increasing in width, greatest width 0.17 mm. near apex. On the under side of apical third a ridge near the outside edge instead of apical thorn. Pubescence on rim of apical fourth about 0.15 mm. long. Sipho, shape normal, compressed just before apex, orifice elongately oval, subapical on outside. (Genitalia very similar to those of *mindanaonis* and *haemorrhoa,* but penis narrower.)

Length.—7 mm. Tips of elytra rounded.

Color and maculation.—Upper side light brownish red, sides of pronotum yellowish. Elytra with the following dark spots: A basal fascia consisting of spots 1 and 2 of the normal pattern not quite reaching the side margin, widest at the suture. Scutellum light. Spot 3 near the suture connected with spot 1, spot 4 wide, touching the margin farther back than No. 3. In addition, a common spot on the suture somewhat farther back than No. 5 usually is prolonged backward to the apical angle. This spot connected lightly with No. 4 at the latter's back inside corner and along the margin of the elytra so that a subapical light area is completely enclosed by a dark region. Pubescence short, light gray all over. Under side and appendages light except tips of mandibles, metasternum and the outside of the apical part of the epipleurae, which are darker.

Type.—National Museum, Stockholm.

Type locality.—Australia, Queensland, Malanda.

Material examined.—2 males: Australia, New South Wales, Innisfail (J. F. Illingsworth, BBM).

Remarks.—Weise's description of the single type specimen gives spots 1 and 2 separated. Otherwise the two specimens agree well with the original description except in unessential details of the coloration of the under side.

The affinity of this species is not quite clear. The spot pattern cannot be clearly recognized as a modification of the normal 12-spotted pattern. Spot No. 6 is either on the suture or absent, which is not observed in any of the 12-spotted species. The male genitalia are very closely related to those of *E. mindanaonis* and *E. haemorrhoa.*

38. EPILACHNA DEYROLLII Crotch

FIGURES 65, 141, 189

Epilachna Deyrollii CROTCH, 1874, p. 78.

Abdomen.—Abdominal plates complete, reaching to within 0.7 mm. of hind margin of first segment. Fifth segment, male, hind margin slightly concave; female, wider, truncate with a slight middle process. Sixth segment, male, slightly emarginate; female, split, inner edges diverging so as to form a notch in the middle of the segment.

Male genitalia.—Penis seen in profile, 1,34 mm. long, straight tube for three-fourths of its length, about 0.21 mm. in middle, gently curved up near end and again sharply turned up immediately before tip, which is a sharp point. Sparsely pubescent on apical half. A lateral depression on each side occupying the last fourth. Seen from below, flattened tube about 0.3 mm. wide, closed at base but split open immediately behind it and the edges gradually becoming wider apart. Apex open, slightly wider, edges rounded. Paramera 1.3 mm. long, becoming gradually narrower from base (width 0.2 mm.) to apex (width 0.1 mm.) and slightly bent down. Flattened, with apical thorn present and sparse pubescence on apical third. Sipho slightly bent, compressed near apex; orifice oval, small at base of compressed part on the narrow edge about 0.15 mm. from tip.

Female genitalia (see fig. 189, which shows, besides the highly sclerotized parts, also the ball-shaped bursa copulatrix and the receptaculum seminis).—Plates 0.6 mm. long. Greatest width 0.38 mm. near its apical fourth, where there is a distinct corner. Inner edge with a gentle emargination on the basal third.

Length.—8.5 to 10 mm. Tips of elytra rounded. Epipleurae of elytra wide, nearly vertical near apex. The reflexed margin of the elytra wide near apex with a more or less distinct longitudinal plica. Mandibles with the two lateral teeth distinctly smaller than the apical one (as in fig. 1 C).

Color and maculation.—Upper side red, pronotum with an indistinct dark spot on the sides; scutellum black; elytra with three fasciae, the first touching the base and dilated along the suture, the second just before the middle and dilated at the margin and suture, and a subapical one also dilated near margin and suture. The suture black except for the apical part beyond the third fascia, the margin black between the second and third fascia. Pubescence light gray all over. Under side mostly black, apical part of abdomen, basal third of elytral epipleurae, and appendages light. The basal parts of the femora and tips of mandibles usually darker.

Type locality.—India, Darjeeling.

Material examined.—2 specimens (PA): India, northern Bengal, Kurseong, June.

Remarks.—This species has its genitalia more different from the majority of species of this group than any so far considered, and it shows other points of divergence, as for example the form of the epipleurae. Its elytral pattern can be regarded as a modification of the normal 12-spotted pattern, with spots 1+2 forming the first fascia, spots 3+4 the second, and 5+6 the third. It has not been mentioned in the literature since its original description by Crotch.

39. EPILACHNA LAESICOLLIS Mulsant

FIGURES 75, 143

E[pilachna] laesicollis MULSANT, 1850, p. 735.

Abdomen.—Abdominal lines subterminal, complete. Fifth segment, male, hind margin slightly concave. Sixth segment with a deep notch.

Male genitalia.—Penis seen in profile, 2.5 mm. long, upper edge departing little from straight line until near the apical bend. Basal knife edge slight though distinct; middle part covered with hairs about 0.3 mm. long. Lower edge characterized by a prominent sharp triangular ridge, which has not been observed in any other species. Tip with a sharp barb on the upper side. Seen from below, orifice just behind the triangular ridge more or less diamond-shaped, 0.4 mm. long. The part of penis beyond the orifice very narrow. Paramera 2.2 mm. long, slender, slightly bent up, compressed laterally for basal two-thirds, with blunt apical thorn. Terminal pubescence dense, about 0.2 mm. long, a single row of longer hairs on the lower inner face for about the last 0.6 mm. Sipho, shape regular, ending in a sharp point, orifice very elongate, subterminal.

Length.—8 to 8.5 mm. Tips of elytra with an angle of about 90°.

Color and maculation.—Upper side black, head and middle of the pronotum from base to apex reddish brown, the side margins narrowly yellowish; elytra each with seven sharply defined yellow spots, as shown in figure 75, and with the reflexed margin around the shoulder and from the second marginal spot to apex yellow. Pubescence short, light gray. Under side, mesosternum and most of abdomen dark, the rest, including the appendages, light.

Type locality.—Himalaya.

Material examined.—4 specimens, all males: India: northern Bengal, Kurseong, June (PA; F. R. Mason, NM); Sikkim; northern India, Darjeeling, alt. 3,000-5,000 feet (L. V. Newton, NM).

40. EPILACHNA ARGUS Fourcroy

FIGURES 57, 149

La coccinelle argus GEOFFROY, 1762, p. 325. (No Latin name used.)
C[occinella] argus FOURCROY, 1785, p. 145.

Abdomen.—Abdominal plates complete, reaching to within about one-fifth (1.3 mm.) of the apical end of the first segment. Fifth segment truncate in male, convex and considerably wider in female. Sixth segment, male, gently emarginate; female, convex, split.

Male genitalia.—Penis seen in profile, curving first down after the middle, then up, so that the apical half forms a gentle arc, concave side up. Seen from below, tube split open longitudinally, seams together for basal two-thirds, then opening and apical third wide open; penis without hairs; paramera very narrow (0.1 mm. wide), 1.0 mm. long, considerably shorter than penis. Covered with hairs near apex, no apical thorn. Sipho strongly curved near base, gently so near apex in the opposite direction. Width diminishing gradually from base to apex, ending in a simple blunt point. Orifice oval on side near apex.

I have examined no other *Epilachna* species with a similar structure of the genitalia.

Female genitalia.—Plates asymmetrically pear-shaped with narrow part at base. Tergite X broad, apex emarginate. No other Eurasian *Epilachna* has a similar structure of the female genitalia.

Length.—6.5 to 7.0 mm.

Mandibles with apical tooth large, lateral teeth much smaller, but both approximately of same size. Lateral dentules present. Claws with triangular basal tooth.

Color and maculation.—Upper side red. Pronotum spotless, elytra with standard 12-spotted pattern with rather small spots, No. 1 on the suture. Under side also reddish, with metasternum and middle of first four abdominal segments partly darker. All appendages reddish.

Type locality.—France.

Feeds on Cucurbitaceae.

Material examined.—Specimens seen from Italy, Turino; Croatia; Caucasus; Algiers.

Remarks.—Very close to *argus,* if not identical with it, is *E. angusticollis* Reiche, which occurs in Spain and southern France. It is supposed to have a larger head, narrower pronotum, and more elongate and less rounded elytra. According to Klemm (1930), the male genitalia are identical with those of *argus,* which makes it rather probable that *angusticollis* cannot be more than a local race of *argus.*

I have seen specimens labeled *angusticollis* from Africa, which were indistinguishable from *argus*.

Epilachna argus seems to occur sparingly over the southern part of Europe. It has been recorded from Spain, France, all Italy, southern and western Germany as far north as Kassel, and Prussia (Reitter), Austria, and North Africa.

41. EPILACHNA CHRYSOMELINA (Fabricius)

FIGURES 56, 145, 197

Coccinella chrysomelina FABRICIUS, 1775, p. 82.

Abdomen.—Abdominal lines complete, broadly rounded, reaching to within about two-fifths of apical margin. Fifth segment, male, truncate; female, biconcave with process in middle (fig. 5 H). Sixth segment, male, strongly emarginate; female, convex, split.

Male genitalia.—Penis seen in profile, 1.6 mm. long, no basal knife edge; gently bent up, with a bulge on the upper side and an emargination on the lower side before the apex, furnished with hairs on side of apical half. Seen from below, narrow tube split open toward apex. Apical quarter widened and forming a deep, oval cavity. Paramera very slender, 1.5 mm. long, furnished with hairs on apical third. No apical thorn. Sipho bent nearly 180° near base, widened at apex so that the swelling prevents the sipho from being drawn through the penis. Orifice terminal, fringed with short bristles.

Female genitalia.—These are considerably different from those of all the other examined species, which emphasizes the isolated position of *chrysomelina* in the genus. The shape of the plates (ninth sternite) is apparent from figure 197. The tenth tergite is split in the middle, in contrast to all the other species, and between the ninth sternite and the tenth tergite is another shorter segment, which according to Verhoeff must be regarded as middle part of the ninth tergite.

Length.—6.5 to 7.5 mm.

The mandibles in profile have three teeth of very unequal size, the apical largest, the middle one considerably smaller, and the second lateral one not very much larger than the dentules. Apical angle of elytra close to 90° but somewhat rounded.

Color and maculation.—Upper side red, pronotum spotless. The typical elytral spot pattern of the species in Asia and most of Europe resembles very much that of the 12-spotted pattern of the *28-punctata* group. However, spot 3 is not significantly farther from the suture than Nos. 1 and 5. There is a great deal of variation in the spot pattern, and different local races behave quite differently in this respect.

Type locality.—Africa.

Remarks.—*Epilachna chrysomelina,* though outwardly resembling many of the other *Epilachna* species of Europe and Asia, differs very considerably in structure from all those species. Neither the male nor the female genitalia are at all similar to any of the Eurasian species. *E. chrysomelina* is essentially an African species and shows its greatest development into variegated forms in Equatorial and South Africa. It must have migrated into Europe and Asia and is now one of the most widely distributed beetles occurring, though with greatly different abundance, from South Africa through the Mediterranean region, southern and middle Europe, and central and southern Asia all the way to eastern Siberia. I have seen an as yet unidentified species from Liberia, West Africa, with male genitalia very similar to those of *chrysomelina,* which confirms the assumption that *chrysomelina* is of African origin and that we must look for its nearest relatives in Africa.

The subspecies and varieties of *chrysomelina* in Africa have been investigated extensively (see Zimmermann, 1936) but are outside the scope of the present paper. Zimmermann divides the forms occurring in the Mediterranean region and elsewhere in Europe and Asia into two subspecies.

The *typical* form, which occurs in the western Mediterranean, shows a number of varieties that differ by the manner in which various spots coalesce. Many of these varieties have received names not worth recording. Some of the more important ones are:

Ab. *nigrescens* Weise, 1879, p. 128. Two or three spots coalesce, for example: 1+2, 2+3, 3+5, 4+6, 3+6, 4+3+5.

Ab. *hieroglyphica* Sulzer, 1776, p. 31. Two separate pairs coalesce: 3+5 and 4+6.

Ab. *elaterii* Rossi, 1794, p. 85. 3+5+6+4.

Ab. *furva* Weise, 1879, p. 128. Like *elaterii* and besides 1+2.

For details of these and other aberrations see: Mader, 1926, and supplement 1932; Leman, 1927; Della Beffa, 1912.

Subspecies *orientalis* Zimmermann, 1936, p. 527. Translation of the original description:

> In comparison with the groundform subsp. *orientalis* is characterized by a flat, not hemispherical curvature of the elytra, by a denser and more closely recumbent pubescence of pronotum and elytra which makes the species appear less shiny; furthermore by the absence of connections between the light ocelli which surround each dark elytral spot and which are more or less clearly visible depending on the general coloration. Such a confluence of the ocelli or more correctly of the light zones on which alone a formation of the black

spots is possible, can take place in *orientalis* only at the front margin of the basal spots, and this is true also for the confluence of the black spots themselves. With the typical form, however, besides these connections, various combinations of confluences also of the four nonbasal spots may take place. As type of subsp. *orientalis* I assign a female from Hedera, Palestine, in the collection of O. Vogt.

Distribution of subsp. *orientalis* according to Zimmermann: Palestine, Cyprus, Egypt, Arabia, eastern Asia Minor, Persia, Turkestan, Tien Shan Mountains.

In North Africa the dividing line between subsp. *orientalis* and the typical form is at the Algeria-Tunisia border, farther north in western Asia Minor. Transition populations occur (e.g., in Constantinople).

E. chrysomelina orientalis interbreeds in the laboratory freely with the typical form.

Obviously it is not easy to tell from isolated specimens to which subspecies they belong, but a fair sample of a population is needed. However, the locality in many cases is sufficient to decide the matter.

Examined by me, specimens from: North Africa, Cyprus, Laos (Tonkin), east Siberia; India, Punjab, Jullunder (1 specimen, D). Weise (1908) reports it from Kerachi, India. The northern limit of distribution in Europe is indicated by the localities Württemberg, Baden in southern Germany, and Bohemia (Reitter, 1911).

All specimens except some of the North African ones belong to subsp. *orientalis*.

Epilachna chrysomelina has been used extensively for genetic studies (Tenenbaum, Timofeef-Ressovsky, Zarapkin, Zimmermann). The relations between the various Mediterranean races have been clarified considerably by a statistical analysis when quantitative measurements of the elements of the spot pattern were used and by controlled breeding experiments. Other *Epilachna* species because of their greater variability would be even better suited for such experiments, and the status of the various subspecies of *E. sparsa,* for example, would be greatly elucidated by such experiments, which would be extremely simple in a warm climate, but judged from the success of the *chrysomelina* experiments should not be unduly difficult in a laboratory in a temperate region. The *chrysomelina* breeding experiments were all carried out in Berlin under laboratory conditions.

BIOLOGY

Details of the habits of *E. chrysomelina* have been given repeatedly, most recently and in greatest detail by Klemm (1930). The observa-

tions were made under laboratory conditions (in Berlin) with specimens imported from Korfu, Greece.

Oviposition begins 6 to 8 days after the first copulation. The eggs are deposited in clusters of 10 to 40, usually on the under side of leaves or on other rough surfaces. One female deposits up to 80 eggs a day, and a total of as many as 322 were observed. The duration of the various stages is as follows (temperature 20° to 25°C., humidity 50 to 70 percent):

	Days
Egg	5-6
Larva	19-26
1st instar	4-5
2d instar	4-6
3d instar	4-6
4th instar	5-6
Prepupa	2-3
Pupa	5-7
Egg to adult average	32-35

Number of generations per year 4, possibly more under more favorable conditions. Copulation occurs from the second day after emergence for female, from the eighth for male. Optimal temperature for development 25° to 30°C. At about 15° to 20° no eggs are deposited; below 15° no copulation takes place.

Both adults and larvae feed on cucurbitaceous plants (cucumber, pumpkins, melons, as well as *Bryonia* and *Ecballium* species). Both the foliage and the fruits are attacked. In southern Europe where the species occurs no serious damage seems to be done, but from central Asia (Turkestan and Transcaspia) heavy damage is reported.

Klemm also describes and figures the immature stages.

ENNEASTICTA GROUP

The three known species of this group hardly differ in external appearance from some of the 12-spotted species of the *28-punctata* group. They can, however, be recognized easily by the structure of the male genitalia, which differs sharply from that of all the other species of the genus.

The general shape of the penis (see figs. 146-148) is less elongate, and seen in profile it is shorter and thicker. Seen from below it appears as a tube for approximately the basal half, but completely open beyond. Whereas the penis tube is split open along its whole length in the other groups of *Epilachna,* it is completely closed without a seam at its basal end in the *enneasticta* group. Beyond the com-

pletely closed part of the tube, the penis has a longitudinal slit of moderate width, and the apical half of the tube is completely open.

The paramera extend somewhat beyond the penis. The shape of the sipho is greatly modified. This is best shown by figure 147. The other two figures represent specimens with the sipho somewhat damaged. The basal part of the sipho is strongly developed, practically as long as the rest of the sipho, and laterally bordered by a wide clear membrane-like structure. The apical part, the sipho proper, is short and relatively wide. It has a constriction at about one-third of its length.

The female genitalia of only one species, *enneasticta,* of the group are known (fig. 199). They are not significantly different from those of the majority of species of the genus, but have the apex of tergite X pointed.

42. EPILACHNA ENNEASTICTA Mulsant

FIGURES 67, 68, 146, 199

E[pilachna] enneasticta MULSANT, 1850, p. 769.

Abdomen.—Abdominal lines complete, subterminal and somewhat angular, the outside edge straight. Fifth segment, male, hind edge concave; female, strongly concave, in the middle emarginate almost to base. Sixth segment, male, emarginate; female, split.

Male genitalia.—Typical for the *enneasticta* group and quite different from those of the majority of the genus. Penis seen in profile, 1.2 mm. long and much thicker than in *28-punctata* group. A longitudinal ridge runs along almost the whole middle of its upper side, a row of hairs (about 0.2 mm. long) on each side of the ridge. Seen from below, 0.5 mm. wide, tube closed completely for the basal 0.3 mm.; the next 0.4 mm. with a rectangular longitudinal slit, about 0.07 mm. wide. Beyond that the tube is half open and widens and flattens just before the end, where it curves upward. Apical edge convex, without a notch (see, however, below). Paramera 1.6 mm. long, narrowing gradually from base to apex without apical thorn. Hairs on the apical half, those at apex very much shorter than those on the sides. Sipho, basal part elongated, about 1.4 mm. long, and well sclerotized. (In fig. 146 the basal part is broken off. Fig. 147 represents this part better, as the sipho of *E. indistincta* is not distinctly different from that of *E. enneasticta.*) The sipho proper is rather wide, with a constriction at about one-third of its length and a sharp subapical notch. The basal tip of this notch is bifurcate; the apical one carries the small oval orifice.

Female genitalia.—Apex of tergite X coming to a point. Plates 0.6 mm. long, greatest width 0.4 mm.; apical edge distinctly emarginate. Inner edge nearly straight.

Length.—7.2 to 8 mm. Tips of elytra rounded.

Color and maculation.—Upper side red, pronotum yellowish at the sides. Elytra each with six black spots. No. 1 close to the suture or touching it, No. 2 on the callus rounded, No. 6 transverse with an emargination on the apical side so that it usually appears crescent shaped. No. 5 slightly transverse, almost touching the suture. Nos. 3 and 4 transverse, in lighter specimens No. 4 not touching the margin, in darker ones both widened so that they form a relatively narrow fascia reaching over on the epipleurae, but interrupted at the suture. Pubescence light gray, dark on the spots. Under side light, with most of the metasternum and the first four abdominal segments except the sides usually dark, occasionally also the mesosternum.

Type locality.—Java.

Material examined.—7 specimens, all from Java (NM): Buitenzorg, March 1909 (Bryant and Palmer); Mount Salak, May 15, 1909 (Bryant and Palmer); East Java, Lawang, 1897.

Remarks.—This species can immediately be recognized by its male genitalia, which are similar only to those of *indistincta*. The crescent-shaped spot No. 6 seems to be characteristic for this species, and the very strongly emarginate fifth abdominal segment of the female serves to distinguish it from all the other known species. (It is to be expected that the female of *indistincta* will show a similar abdominal structure.)

Among the males there is one specimen that has the apex of the penis distinctly notched, whereas the specimen from which the figure was made shows no trace of such a notch. The notched specimen also had a less distinct ridge on the upper side of the penis, and there are other less pronounced variations. Whether this should be regarded as a separate species or merely within the range of variation of *enneasticta* can only be decided with much more material. The latter view is supported by another specimen that shows a faint emargination at the apex of the penis and seems to be an intermediate between the two other specimens also in other respects.

43. EPILACHNA INDISTINCTA, new species

FIGURES 69, 147

Abdomen.—Abdominal lines complete, subterminal, angulate. Fifth segment, male, mildly concave. Sixth segment, apex wide, moderately concave.

Male genitalia.—Penis seen from below, 1.4 mm. long. The basal part a wide tube, completely closed for the basal 0.3 mm.; for the next 0.35 mm. with a narrow longitudinal slit, oval at its base and slightly narrowing toward its apex; from then on the penis is completely open, widened at its apex and curved up. Seen in profile, with a blunt ridge on the upper side and a row of hairs on each side of it. Paramera slender, 1.4 mm. long, protruding beyond the penis, almost parallel or slightly tapering toward apex. Clothed with very short hairs at apex, somewhat longer ones (0.15 mm.) on the remainder of the apical third. Sipho of the shape indicated in figure 147 with the long basal piece to which is attached laterally a clear blade-like stiff membrane, damaged near the basal end in the type and the outline uncertain in the figure. The sipho proper with the constriction near its base and the subapical notch characteristic for the *enneasticta* group. The basal point of this notch is forked; the apical one has the small oval orifice.

Length.—7 mm. Reflexed margin of elytra very distinct.

Color and maculation.—Upper side light yellowish brown. Sides of pronotum yellow. Elytra each with six rather small spots. Pubescence light gray, short, dark on the spots. Under side and appendages light brown, tips of mandibles and metasternum partly dark.

Material examined.—Type: U.S.N.M. No. 57133, Sumatra, Siantar (Mann, 1937, N.G.S.-S.I. Exp.).

5 paratypes, all males: Sumatra, Pagaralam and Fort De Kock (C. T. and B. B. Brues, MCZ, D).

Remarks.—This species is not conspicuously different externally from the other 12-spotted species but can immediately be recognized by its male genitalia, which resemble those of *E. enneasticta* Mulsant. From the latter it can be distinguished by the absence of the lateral ridge near the apex of the penis and the fact that the longitudinal slit is oval at the base and not truncately cut off.

44. EPILACHNA SEMIFASCIATA, new species

FIGURES 70, 148

Abdomen.—Abdominal lines complete, subterminal, outside straight. Fifth segment, male, hind margin mildly concave. Sixth segment the same.

Male genitalia.—Same general shape as the two other species of the *enneasticta* group, but with quite pronounced differences. Penis seen from below, wide tube (width about 0.35 mm.). Only the first 0.1 mm. completely closed, the next 0.35 mm. with a narrow longitudinal

slit in the middle widened ovally near the base, less than 0.03 mm. wide near apex; beyond this a deep narrow trench, which ends near the blunt point that forms the apex of the penis. This apical third laterally bordered by a horizontal process. Seen in profile, small basal knife edge not reaching farther than the base of the paramera. Paramera 1.15 mm. long, slightly curved downward. Sipho: the base shows the same extended structure as in *enneasticta* and *indistincta,* and also the general shape is the same, but the tip has quite a different structure. Seen from the outside about 1.15 mm. before the end is a lateral constriction. There is a median sharp ridge of about 0.035 mm. length, and on each side a lateral ridge interrupted at the constriction.

Length.—5.5 mm. Tips of elytra rounded.

Color and maculation.—Upper side brick red; pronotum with all seven spots faintly present with hazy outlines, the middle three coalescent; each elytron with six dark spots, Nos. 1 and 5 touching the suture, Nos. 4 and 6 touching the margin; all spots except No. 2 laterally widened, No. 3 most (0.8 mm. long, 1.6 mm. wide). Nos. 3 and 4 form a transverse fascia interrupted by a gap of 0.1 mm. width between 3 and 4, and one of twice 0.3 mm. at the suture. Pubescence light gray, dark on the spots. Under side partly dark, appendages, except tip of mandibles, light.

Type.—U.S.N.M. No. 57134, Formosa, Musha, May 1, 1929 (K. Sato).

Remarks.—The maculation of *E. semifasciata* agrees very closely with that of *E. subfasciata* Weise (1923b, p. 182), also from Formosa. However, Weise gives a short description of the genitalia of this species, which are quite different.

GUTTATOPUSTULATA GROUP

Besides *guttatopustulata* (Fabricius) a few other species with dark ground color have been placed here. Most of them differ from the rest of the genus by the structure of the female genitalia, which have the plates transversely oval. The male genitalia, however, are known only in two cases. *E malkini* is so different, particularly in the absence of the tarsal tooth, that it probably should be put into a separate group.

45. EPILACHNA GUTTATOPUSTULATA (Fabricius)

FIGURES 71, 144, 200

Coccinella guttatopustulata FABRICIUS, 1775, p. 87.

Abdomen.—Abdominal lines complete, reaching to within about one-third of the apical margin of the first segment. Fifth segment,

male, truncate, slightly emarginate; female, slightly convex. Sixth segment, male, with a deep notch; female, split. Tergite VIII emarginate.

Male genitalia.—Penis seen in profile, straight tube for most of its length, decreasing gradually in width, then rather suddenly curved up. Apical point with trace of a hook. Seen from below, tube with the seam sometimes apart during its entire length, flattened and widened near the middle. From apex of orifice to point, 0.2 mm. Penis without hairs. Basal knife edge rudimentary. Paramera 1.7 mm. long, widest near the middle, narrowed considerably toward apex, without apical thorn. Apical hairs sparse, about 0.2 mm. long; also one row of hairs on edge starting just behind the widest part. Sipho long and slender, curved through 180° near base, ending in blunt point.

Female genitalia.—Tergite X with apical margin broadly truncate with a trace of an emargination. Genital plates obliquely widened with a not very distinct basal edge.

Length.—8 to 8.5 mm. Apical angle of elytra rounded; claws (fig. 2 C) with quadratic tooth which has a small, toothlike process on the inside. Mandibles with the first lateral tooth slightly smaller than the apical one, the second lateral tooth smaller than the first; dentules present.

Color and maculation.—Upper side, head reddish, pronotum yellow with a big central black spot reaching from base to apex. Elytra black with two subbasal spots, the inner one on the suture red, the outer one on the margin yellow. In addition a subapical red fascia convex forward and usually interrupted at the suture. Under side and appendages mostly black. Prothorax, parts of epipleurae adjacent to the light parts of the elytra, and the outer margin of the first four and usually the complete fifth abdominal segments light.

Type locality.—Australia.

Material examined.—12 specimens. Australia: Tambourine Mountain, October 28, 1912 (H. Hacker, NM; Koebele; Bridwell coll.); New South Wales, Richmond River; Sydney, Grafton, O'Kelly, on sugarcane. Central York, Queensland, Tasmania, listed by Crotch. New Guinea (NM).

Remarks.—This species is considerably removed from the vast majority of the other *Epilachna* species. Its female genitalia resemble much more those of *Afissa maxima* than those of any other *Epilachna*. The deep notch in the fifth abdominal segment of the male and the male genitalia also set it apart.

EPILACHNA GUTTATOPUSTULATA subsp. TRICINCTA (Montrouzier)

FIGURE 72

Coccinella tricincta MONTROUZIER, 1855, p. 76.

Differs from the main form by the reduction of the black pigment. The spot of the pronotum is only faintly indicated. The two subbasal spots are united and the subapical fascia enlarged. This form gives the appearance of a yellowish-red upper side, with a dark basal and a discal fascia and an apical spot at the suture. The under side and appendages are entirely light.

Type locality.—Woodlark Island.

Material examined.—24 specimens: New Guinea (NM); Dutch New Guinea, Hollandia, January, April, May, 1945 (B. Malkin, NM, D).

EPILACHNA GUTTATOPUSTULATA subsp. TASMANICA Crotch

Epilachna guttato-pustulata var *tasmanica* CROTCH, 1874, p. 78.

Crotch's original description is as follows: "Var. *tasmanica*. The yellow marginal spot is replaced by red, the black pigment is diminished, the posterior fascia deeply angulate, the apical spot enlarged."

Type locality.—Tasmania.

Material examined.—1 specimen answering this description: New Hebrides, Espiritu Santo, September 1944 (K. L. Knight, NM). Female genitalia like those of *guttatopustulata* s. str.

46. EPILACHNA BIROI Weise

FIGURES 73, 202

Epilachna Birói WEISE, 1902, p. 491.

Abdomen.—Abdominal lines complete, reaching to within one-third of the hind margin of the first segment, slightly angulate. Fifth segment, female, hind margin truncate with a slight process in the middle. Sixth segment, split.

Female genitalia.—Plates transversely oval. The rest not available. Length 0.23 mm., width 0.40 mm., inner edge convex.

Length.—7 mm. Apical angle of elytra rounded.

Color and maculation.—Upper side black, the head lighter; pronotum with a yellowish-red side margin; elytra each with two red spots, one humeral, the other apical. Under side black, apex of abdomen lighter; epipleurae light in the parts corresponding to the elytral spots.

Type.—Hungarian National Museum (?).

Type locality.—New Guinea, Sattelberg.

Material examined.—1 specimen: Philippine Islands, Luzón, Manila (D).

Remarks.—The only available specimen agrees well with Weise's description of *biroi*. Whether it is closely related to *guttatopustulata* is not quite clear, as only a somewhat mutilated female is available. However, the genital plates resemble in form those of *guttatopustulata* much more than those of any other species, and the black ground color is another point of similarity.

47. EPILACHNA CIRUNIGRA, new species

Abdomen.—Abdominal lines incomplete, the inner arc distinct and reaching to within one-fourth of the hind margin of the first segment, the outer part indistinct. Fifth segment, male, hind margin slightly concave; female, convex. Sixth segment, male, with semicircular notch; female, split, apex of halves with nearly right angle.

Male genitalia.—Penis seen in profile, 1.2 mm. long, upper edge straight until shortly before tip, when it curves up suddenly through a 90° angle. Narrow rudimentary basal knife edge present; two rows of hairs on middle part. Seen from below, tube split open for entire length and seams about 0.05 mm. apart. Paramera 0.95 mm. long, only about 0.1 mm. wide on apical half, slightly wider near base, rim covered with hairs on apical third. Sipho bent through 180° near base (as in fig. 144), tip rounded, slightly swollen, with orifice subterminal on side.

The genitalia of *E. cirunigra* resemble most closely those of *E. guttatopustulata* Fabricius (fig. 144). They differ by the fact that the penis is more suddenly curved up near its tip, that the paramera do not have the sudden decrease in width, and that the tip of the sipho is swollen rather than constricted.

Female genitalia.—Plates transversely oval with the outer edge more pointed than the inner one, length 0.30 mm., width 0.35 mm.; the inner half of the basal edge of both plates taken together forms an arc that is convex toward the apex. The shape of the plates resembles most that of figure 202 (*biroi*). Tergite X with strip of pigment on each side, middle clear.

Length.—7.5 to 8.5 mm. Tooth of claws square; tips of elytra rounded. Mandibles with the apical tooth widened with traces of doubling. Two lateral teeth, the outer one bigger above the apical tooth and its tip actually farther outward than the apical tooth. The

inner one much smaller. Trace of one dentule between the two lateral teeth.

Color and maculation.—Upper side, head, scutellum, and middle of pronotum reddish brown, the sides yellow. Elytra, black with two big red spots on each elytron. One spot covers the shoulder and takes up the outer two-thirds of the base and the front third of the margin. Its inner edge is evenly curved. The other spot covers roughly the apical third and reaches both suture and margin. Its basal margin is convex forward. (The maculation is very similar to that of fig. 74 except that the spots are larger.) The pubescence is light gray on head and pronotum, black on the black parts, and reddish on the red parts of the elytra. Under side light brown except the tips of the mandibles and the middle of the epipleurae, which are dark. The apical part of the metasternum also darkish.

Material examined.—Type: U.S.N.M. No. 57968, from Hollandia, Dutch New Guinea, June 1945 (B. Malkin).

7 paratypes, from same locality as type, January, April, June, 1945 (NM, D).

Remarks.—This species is very close to *E. biroi* Weise but differs sufficiently from Weise's description to warrant listing as a new species. The most conspicuous difference is the black color of the pubescence on the dark parts of the elytra. *E. biroi* is supposed to have gray pubescence except on the red spots.

The genitalia and the general structure leave no doubt that *E. cirunigra* belongs in the same group as *E. guttatopustulata* Fabricius.

48. EPILACHNA MALKINI, new species

Abdomen.—Abdominal lines complete, rounded, not reaching much beyond the middle of the first segment. Fifth segment, female, with straight or slightly convex hind edge. Sixth segment, female, emarginate, split.

Female genitalia.—Plates 0.28 mm. long, 0.32 mm. wide; inner edges straight, together with a heart-shaped notch at the very base, basal edge slightly, outer edge more strongly curved, apical edge emarginate.

Length.—6 mm. Tarsal claws split but without a distinct tooth.

Color and maculation.—Upper side, head, and pronotum reddish brown, sides of latter lighter; elytra black with a round reddish spot in the hind third which reaches the margin but not the suture. Under side and appendages light except the metasternum, the tips of the mandibles, and the front two-thirds of the epipleurae, which are darker. Pubescence uniformly whitish gray.

Material examined.—Type: U.S.N.M. No. 57969, from Hollandia, Dutch New Guinea, April 1945 (Malkin). Paratype: Same data (D).

Remarks.—This species is markedly different from the other species of *Epilachna* by having the tarsal claws without a distinct tooth, and in this respect it resembles the species of *Afissa*. However, in all other respects it is much closer to the rest of *Epilachna* than *Afissa*. In particular the sixth abdominal segment of the female shows a distinct suture, which is always absent in *Afissa*. For this reason it seems best to consider *E. malkini* as belonging to *Epilachna*. A knowledge of the male will probably shed further light on this question.

E. malkini is probably closely related to *E. haematomelas* Boisduval, which according to Weise also has toothless claws. The latter has a humeral red spot in addition to the subapical one and has pronotum, under side and legs black. Its size is considerably larger (length 10 mm.).

From the rest of the *Epilachna* species *E. malkini* is easily distinguished by the toothless claws, the emargination in the sixth abdominal segment of the female, and the genital plates. These are distinguished by the fact that the notch at the inner edge, present in many *Epilachna* species, reaches to the basal edge, whereas it remains somewhat distant from it in the other species.

AFIDENTA, new genus

Genotype: *Afidenta mimetica,* new species.

Claws bifid with a sharp basal tooth. Sixth abdominal segment of female not split lengthwise.

The two known species of this genus, although quite different in appearance, have a very similar structure of the genitalia, different from that of any oriental species of *Epilachna* and *Afissa*. It is the most primitive, least elaborate form observed in any species of the subfamily Epilachninae and is much smaller in relation to the body size than other species. The establishment of a new genus for these two species seems therefore to be justified, at least provisionally. The structure of the tooth of the claw differs from that of *Epilachna* in that it has an irregular, weakly sclerotized outside edge (fig. 2 D). *Epilachna bisquadripunctata,* although differing in some respects from the two other species, has been temporarily placed in this genus.

1. AFIDENTA MIMETICA, new species

FIGURES 74, 157, 201

Abdomen.—Abdominal lines complete, subterminal, nonangulate. Fifth segment with hind margin very slightly convex in both sexes. Sixth segment, male, convex; female, emarginate, not split.

Male genitalia.—Smaller than in *Epilachna.* Penis seen in profile, 0.5 mm. long, wedge-shaped, with the upper margin nearly straight and the lower one slightly curved up. Apical point straight, not curved up. No hairs on penis, no basal knife edge. Seen from below, straight tube, pointed toward apex; split longitudinally with the seams apart. Paramera 0.5 mm. long, about 0.1 mm. wide, without apical thorn, slightly curved outwardly and with hair on the apical half. Sipho short, moderately bent near base, narrowed near apex, orifice subterminal on side, very elongate.

Female genitalia.—Tergite X with apical margin very convex, pigment in two strips along the side. Genital plates diagonally suboval, mildly emarginate on outer apical side.

Length.—5.0 to 5.5 mm. Tips of elytra rounded. Mandibles with a split apical tooth and two lateral ones, the more basal one smaller. No dentules.

Color and maculation.—Upper side brownish red, pronotum with a transverse row of four black rounded spots near the middle or just in front of it, spaced equidistantly, these spots occasionally obsolete. Elytra each with 14 black spots arranged as in *Epilachna 28-punctata* or allied species without any significant differences. Pubescence dense, light blond, dark on the spots. Under side and appendages light, sides of metasternum darker. In the Tibet specimens mesosternum and metasternum and abdomen also dark.

Material examined.—Type: U.S.N.M. No. 57135, Indochina: Annam Prov., Haut Donai, Col de Blao, alt. 900 meters, September 30, 1932 (M. Poilane).

30 paratypes (NM, MNH, MCZ, D): China: Shantung Prov., Yen-Ping, July, September, 1917 (AMNH); Anhwei Prov., Taipingshien, October 1932 (G. Liu, MCZ); Kwangsi Prov., Yao Shan, Yungshien, Peiliu, Wuchow, Pingliu, Yueling, Kweiping, Kweishien, March-May 1933 (G. Liu, MCZ); Fukien Prov., near Foochow (Kellogg, NM); Tibet (AMNH).

The specimens from Anhwei, Shantung, and Tibet are dark with large spots, those from Kwangsi lighter with small spots.

Remarks.—This species must have been confused hitherto with one of the 28-spotted *Epilachna* species, which it resembles very

closely and which occur in the same locality. From these it can be easily separated by its smaller size and particularly the spot pattern of the pronotum. The female abdomen and the male and female genitalia give, of course, infallible criteria for separating it from these *Epilachna* species.

AFIDENTA MIMETICA SIMPLEX, new subspecies

Structure and male genitalia the same as in *A. mimetica* s. str. Pronotum with the same transverse row of four black spots. Elytra, however, each with only the six persistent dark spots, which are rounded and arranged as the persistent spots of *mimetica* s. str.

Type.—Museum of Comparative Zoology, from India, Kooloo (Carleton).

2. AFIDENTA MINIMA (Gorham)

FIGURE 80

Epilachna minima GORHAM, 1894, p. 206.

Abdomen.—Abdominal lines subcomplete, subterminal, apex subparallel to margin of first segment. Fifth segment, male, hind margin truncate to slightly convex; female, convex. Sixth segment generally not protruding from under the fifth; male, convex with a slight apical emargination; female, not split, convex.

Male genitalia.—Penis seen in profile, 0.35 mm. long, wedge-shaped, slightly bent upward immediately before the tip, no hairs. Seen from below, open tube ending in two sharp points. Paramera bent lightly up near base, slender, 0.35 mm. long, 0.035 mm. wide, very sparsely pubescent near apex. Sipho bent 180° near base, orifice oval on side, subterminal.

Female genitalia.—Tergite X wide, apical margin mildly convex, a strip 0.04 mm. wide along this margin pigmented. Genital plates irregularly diagonally oval.

Length.—2.6 to 2.9 mm.

Color and maculation.—Upper side light brown. Elytra with the basal and lateral margins and three spots dark. The dark margins often absent. Under side light, mesosternum and metasternum dark.

Type locality.—India, Belgaum.

Material examined.—India: Mangalore, August 1926, August 1924, November 1926, on grass (J. C. Bridwell, NM, 11 specimens); 1924-1926 (J. C. Bridwell, 2 specimens); Goa, Murmugao, September 1925 (J. C. Bridwell, 4 specimens); Dehra Dun Distr., August 14, 1944 (J. Unyal, D).

Remarks.—Gorham's original description gives the under side as black, which probably means only that he had darker specimens of this species. He reported them as found under bark in December.

3. AFIDENTA BISQUADRIPUNCTATA (Gyllenhal)

FIGURE 223

Cocc[inella] bis 4-punctata GYLLENHAL, *in* Schönherr, 1808, p. 186.
E[pilachna] herbigrada MULSANT, 1850, p. 805.

Abdomen.—Abdominal lines rounded, subcomplete, reaching to within one-fourth to one-third of the hind margin of the first segment. Fifth segment, male, hind margin truncate; female, wide, convex with a very small notch in the middle. Sixth segment, male, emarginate; female, entire, convex.

Male genitalia.—Penis seen in profile, 0.93 mm. long, straight tube, thickened just before apex, appearing to end in a sharp, upturned point (this appears as a point only when seen in profile). Seen from below, subparallel tube, seams gradually diverging in last third and completely open in last fifth, apex bilobed. Paramera very thin, 0.9 mm. long, bent down slightly at base, width 0.03 mm., only slightly widened at apex, and apex sparsely clothed with hairs. Sipho bent through 180° near base, slightly widened at apex when seen sidewise, compressed when viewed in plane of bend from convex side. Orifice subterminal.

Female genitalia.—Plates rounded with the base somewhat flattened, diameter about 0.26 mm.; tergite X, wide (0.85 mm.), mildly emarginate.

Length.—4 to 5 mm. Tarsal claws split, both parts slender and with a distinct triangular tooth; mandibles very different from any of the other observed structures in this group. They are not flat as in the *Epilachna* and *Afissa* species, but about as thick as they are long and wide. There is a broad flattened apical tooth and two shallow, broad, lateral teeth along the inner rim. There is another tooth not far from the more basal one of the two lateral teeth but apart from it and in a different plane.

Color and maculation.—Upper side brownish red; head and pronotum spotless, elytra each with four black spots, the first near the base about halfway between shoulder and suture, the second slightly in front of the middle separated from the suture by less than its own diameter, the third one about as close to the margin and slightly farther in front. The fourth spot about one-third of the length of the elytra from the apex, about as close to the margin as to the suture.

The spots are usually rounded, the diameter about one-fourth the width of the elytra, or some may be transversely widened. Pubescence light gray, dark on the spots. Under side light except metasternum and base of abdomen, which may be darker.

Type locality.—East Indies; for *herbigrada,* Pondicherry.

Material examined.—7 specimens (MCZ; D): India: Kooloo (Carlton); southern India, Malabar, Walayar Forest, 700 feet, November 16, 1945 (Nathan). China: Kwangsi Prov., Kweiling, April 1933 (G. Liu).

Remarks.—There has been some dispute as to whether *bisquadripunctata* Schönherr and *herbigrada* Mulsant are the same species. The difference is supposed to be that in the former the spots are transversely widened while in the latter they are round. In some of the Indian specimens some of the spots are widened and the others round, which suggests that there is no difference between the two forms. The Chinese specimens would belong definitely to *herbigrada.* Their size is a little smaller than that of the Indian specimens.

The presence of the tooth on the tarsal claws and the absence of splitting of the sixth abdominal segment of the female would put *bisquadripunctata* in *Afidenta.* The genitalia are, however, quite different from those of the two other species of *Afidenta.* This and the very peculiar structure of the mandibles suggests that *bisquadripunctata* belongs to a new genus. In the absence of further information, however, it is left for the present in *Afidenta.*

AFISSA, new genus

Among the Eurasian genera, *Afissa* is quite clearly differentiated from *Epilachna,* and there never can be any doubt to which of the two genera a given species belongs. The species of *Afissa* do not form nearly so homogeneous a group as those of *Epilachna,* which have hardly any morphological differences. The shape and size may vary greatly: some species have quite remarkable modifications of the structure of some of the abdominal segments, others have distinct cavities in the epipleurae for the reception of the tips of the femora.

The spot pattern is also more varied. The pronotum may be spotless or have a discal spot or three spots of various shape, or the dark color may take up practically the whole surface of the pronotum, with all sorts of intermediates. The elytral pattern of some species resembles very much that of some of the *Epilachna* species with six spots on each elytron (see fig. 81 or 91). A few species have more than six spots; the additional spots, however, do not behave at all like the nonpersistent spots of *Epilachna.*

The basal pattern for the majority of the *Afissa* species, however, consists of five spots arranged 2, 2, 1 as in figure 88. Many modifications, such as the coalescence of various spots, occur, but on the whole the 5-spotted pattern can clearly be recognized.

Much less is known about the variability of the spot pattern of the various species than for *Epilachna,* as the number of specimens available for most species is rather limited. Details about this will be found under the various groups. The variation of the spot pattern for many species for which fair series are available seems to be quite small (for instance, the 35 specimens of *flavicollis* from a very extended region show hardly any variation in the elytral pattern at all). On the other hand, it was found from the study of the genitalia that some forms with seemingly quite insignificant differences in the spot pattern belong to distinctly different species.

The male genitalia show a great variety of structures and form an excellent criterion for the identification of species. The chief differences from those of *Epilachna* seem to be, when the structures seem otherwise very similar, that there is never a basal knife edge and very rarely any pubescence on the penis, and in the few cases that it is there it is very sparse. The paramera never have an apical thorn.

The female genitalia also show a great variety in structure and are very good for a classification into various groups.

The distribution of *Afissa* is less wide than that of *Epilachna.* It is completely absent from Europe and Australia and probably does not cross the deserts of central and western Asia. Its center of greatest development seems to be in southern China. It is well represented also in India. A smaller number of species occur on the East Indian Archipelago, and only two species are known from the Philippines. It apparently does not reach New Guinea and the Pacific islands. Going north from its center of distribution, the number of species diminishes rapidly, and only one species, *admirabilis* Crotch, has been reported from northern China and Japan. It never has been recorded from Manchuria and Siberia.

Very little is known of the biology of *Afissa* species. Apparently none of the species occur as serious pests, partly because the number of their individuals does not become very large, partly because the chief food plants are of no economic importance. At least this is true for *A. admirabilis,* the only species the habits of which have been studied at all. A great variety of mandibular structures has been observed in *Afissa,* and it would be interesting to know whether differences in food habits go together with this. A striking difference between the habits of *Afissa admirabilis* and the *Epilachna* species

is the fact that the former hibernates as larva. It is unknown, however, whether this is true for *Afissa* in general.

Probably only a rather small portion of the total number of *Afissa* species is known at present. This at least may be concluded from the fact that in the material from China available to me for study 15 of the 23 species are new, many only represented by one or two specimens. Almost all this material came from a rather limited region in Szechwan Province. It must be expected that, if careful collecting is done in other parts of Continental Asia with the proper climate, a similar yield in new species will result.

The genus *Afissa* can be subdivided into several more or less well defined groups which are characterized by the type of spot pattern and the structure of the genitalia and of the abdomen. The following key tries to use the spot pattern as much as possible:

1. Elytra each with six or more spots, which may be more or less united to form transverse fasciae; in which case the fascia in middle of elytra is bent back in form of a V near suture 2
   Elytra each with five or less spots; if these are united into transverse fasciae, the middle one is nearly straight 3
2. Length more than 6 mm ..... **admirabilis** group
   Length less than 6 mm ..... **fallax** group
3. Abdomen smooth in both sexes 4
   Abdomen deeply sculptured especially in male and often with a process on fourth or fifth segment ..... **complicata** group
4. Female genitalia of *flavicollis* type, tergite X not folded back, epipleurae smooth ..... **flavicollis** group
   Female genitalia with apex of tergite X folded back 5
5. Epipleurae without distinct cavities ..... **szechuana** group
   Epipleurae with cavities for the reception of the tips of hind femora ..... **chapini** group

I. ADMIRABILIS GROUP

This is a well-characterized group and consists of six known species. The female genitalia of all of them are known and perhaps are the best characteristic of the group. Tergite X is either emarginate or broadly truncate. The plates are ovaloid and more or less pointed at the base. The male genitalia, known only for three species, have the penis as a simple tube moderately curved and ending in a single point. The sipho is long and slender with a bend of about 180° near its base.

Group I consists of the largest species of the genus. The average size of each species is more than 7.5 mm. Only exceptionally small specimens of *admirabilis* have been found to be as small as 6 mm.

The typical pattern consists of six spots on each elytron, very similar to some species of *Epilachna*. Spots 1 and 5 are usually on the suture. The humeral spot (2) is split up into two separate spots in forms of insignis and maxima so that each elytron then carries seven spots. A tendency for this splitting is evident in other species (e.g., *admirabilis*).

Variability of the maculation.—The pronotum may vary from completely light to almost completely black. The elytral pattern shows a tendency to form two transverse fasciae, one consisting of spots 1 and 2, the other of spots 4+3+5. A good series in the National Museum shows the complete development for *admirabilis*. For the other species the material at my disposal is too scant to follow the complete development, but Korschefsky (1933b, p. 301) gives a complete sequence for *grayi* (fig. 107).

From the other groups of *Afissa,* except the *fallax* group, the *admirabilis* group can easily be separated by the spot pattern. The species of the *fallax* group, which have a similar spot pattern, are all considerably smaller in size. In all cases the female genitalia are probably the safest criterion.

1. AFISSA ADMIRABILIS (Crotch)

FIGURES 76, 150, 203

Epilachna admirabilis CROTCH, 1874, p. 81.

Abdomen.—Abdominal lines subterminal, externally not quite complete. Middle part of first segment (as well as metasternum) with big circular punctures, which diminish in size toward the apex, diameter near the base about 0.04 mm. Fifth segment, male, truncate; female, with a process in middle. Sixth segment, male, hind margin with notch; female, evenly convex.

Male genitalia.—Penis seen in profile, 1.3 mm. long, ending in sharp straight point; lower edge slightly concave, upper strongly convex, making the profile widest in the middle. Seen from below, as in figure 150, with ovaloid orifice. Paramera 1.5 mm. long, rather strongly curved down, widened and flattened toward apex, greatest width 0.2 mm., apical two-thirds with long (up to 0.4 mm.), light blond hairs. Sipho with 180° bend near base; orifice terminal, surrounded by a circle of short bristles.

Female genitalia.—Apex of tergite X deeply emarginate; plates ovaloid, 0.7 mm. long, pointed at base, greatest width about 0.38 mm. Stylus short, apical part with rather long hairs, about 0.3 mm. long.

Length.—6 to 9 mm. Mandibles with big apical tooth and two lateral ones, considerably smaller. In addition a number of dentules of very unequal size, smallest near base.

Color and maculation.—Upper side brownish red to brownish yellow; head spotless; maculation of pronotum and elytra rather variable. The form apparently most common in eastern China and Japan (fig. 76) has the pronotum black with the front edge narrowly, and the sides more widely light, scutellum light. (Lewis, 1896, gives it as dark, although a specimen in the Casey collection collected by Lewis has also a light scutellum.) Elytra each with six large spots, Nos. 1 and 5 on the suture forming with their counterparts on the other elytron two rounded common spots. No. 1 touching the scutellum in front and usually slightly elongate. No. 4 semicircular, broadly touching the margin and reaching over to the epipleurae. Nos. 2 and 6 subcircular. Pubescence black on the spots, light gray elsewhere. Under side light, metasternum, abdomen, epipleurae, and femora usually dark in varying degree.

The maculation may vary in the direction of more or less pigment. Light specimens seem to occur chiefly in eastern China (Soochow, Nanking, Kiang-su). The pronotum may be completely light or may have a discal and two basal spots in approximately the position of spots 1-4 of *Epilachna* (fig. 4 E) with 3 and 4 united, or may approach the standard dark form. The elytral spots in the lightest specimens I have seen are much reduced. In one specimen spot 6 has practically disappeared. The common spots 1 and 5 are resolved into two oval spots each narrowly separated by the suture. No. 2 usually has a strong emargination in front of the callus.

In the darker specimens spots 3 and 4 or 4+3+5 flow together. According to Lewis (1896) Crotch's type belongs to the latter form, and it occurs in Japan in about 1 out of 13 specimens. Mader states that the head is also dark in his specimens.

Type locality.—"China (Deyrolle), King Hing, Japan (Miniszech)."

Material examined.—16 specimens: Japan (Lewis, NM, MCZ). According to Takahashi (1932) it occurs all over Japan but is more frequent in the cooler parts. China: Kiang-su Prov., July 3, 1921 (E. Suenson); Soochow (C. F. Wu.); Kiang-si Prov., Nanking; Anhwei Prov., Kiuhua Shan, September 1932 (G. Liu); Hupei Prov., Wuchang, 1932. The Hupei specimen with spots 1+2, and 3+4+5 joined.

AFISSA ADMIRABILIS subsp. CONTINENTALIS, new subspecies

FIGURE 77

The specimens of *Afissa admirabilis* occurring in Szechwan Province, China, are sufficiently different from those found farther east in China and Japan to form a distinct subspecies. The shape is somewhat more elongate, and the color is brownish yellow instead of reddish (this may be due only to a different way of preservation). The fine punctures on the elytra are more distinct and numerous, and the maculation is considerably different. The genitalia are not significantly different from those of the typical form.

The pronotum is usually black with light front and side margins, which are wider than in the typical specimens. Occasionally the black spot is broken up into a discal and two basal spots. In the most fully developed specimens spots 1+2 and 4+3+5 of the elytra are connected to form two transverse fasciae (fig. 77). The form with all spots separated (except 1 and 5, which are united with their counterparts on the other elytron) is found in Szechwan but is rare. All intermediates between this and the fully developed form occur. Spot 6 is commonly rounded and separate, but in one specimen it is connected with No. 5.

Material examined.—Type: U.S.N.M. No. 57136, China, Szechwan Prov., Hua Yin Shan (70 miles north of Chungking), alt. 2,500 feet, July 5, 1923 (D. C. Graham).

Paratypes (NM, MCZ, D) from the type locality and the following additional localities, all China: Szechwan Prov., near Wen-Chuan, alt. 4,000-6,000 feet, May-August 1933; Huping, July 25, 1929; Beh Luh Din, 30 miles north of Chengtu, alt. 6,000 feet (D. C. Graham); Hua Yin Shan, August 1932; Chingcheushan, July 1932 (G. Liu).

Remarks.—It is quite possible that *Solanophila adscita* Mader (1930, p. 184) is nothing but a form of *Afissa admirabilis continentalis,* and if that should be verified the name *adscita* has, of course, priority. Nothing in the description reveals any significant differences, and I have seen specimens of *Afissa admirabilis* with very nearly the maculation of Mader's figure of *adscita.* A comparison of the genitalia only would give certainty.

Type locality of *adscita* Mader: China, Szechwan Prov., Yunling Mountains.

BIOLOGY

A. admirabilis is the only species of *Afissa* of which anything is known about the life habits. Its biology differs in some important

respects from that of the *Epilachna* species, and it would be interesting to see from a study of further species if these differences are characteristic for the genus. The following data are taken from an account of the life history of *A. admirabilis* in Japan by Takahashi (1932).

The life cycle is 1 year. The insect hibernates as a full-grown larva on the fallen dead leaves of various grasses piled up in pine and other woods where the food plant occurs. In spring the larva pupates without taking up feeding again. The adults emerge late in April or early in May and are found from then until the end of November, when they die. Egg laying occurs during August and September, with the peak around the middle of August. The eggs are laid singly or in small groups up to five or six and are usually glued to tendrils of the food plant, more rarely to the under side of leaves. The female was observed to lay up to 36 eggs a day and up to 394 in total. As only a few cases were observed, it is uncertain whether these figures are representative.

The larva has four instars, and the duration of the various stages is as follows:

		Average
Egg	11-13 days	12.4 days
Larva, 1st instar	6-9	7
2d	9-12	9.8
3d	13-18	15.4
4th until end of growth	17-26	22
Hibernation until pupation	170-210	187.6
Pupa	20-24	21.6
Egg to adult		275.6

The food plants, in the order of preference, are:

1. *Trichosanthes cucumeroides* Maxim.
2. *Trichosanthes japonicus* Regel.
3. *Melothria japonica* Maxim.
4. *Actinostemma lobatum racemosum* Mak.
5. *Momordica charantia* L. (balsam pear).
6. *Luffa cylindrica* Roem.

All are cucurbitaceous. Nos. 1 and 2 are weeds; 5 and 6 were attacked only when no other food was available. *Cucurbita moschata* var. *toonas* (squash), *Citrullus vulgaris* Schrad. (watermelon), and *Cucumis melo* L. (melons) were not taken when offered in the laboratory.

Figures and descriptions of the immature stages are also given by Takahashi.

Because the chief food plants are weeds and because the insect is never found in large numbers, *Afissa admirabilis* is of no apparent economic importance. The fact that there is only one generation a year does not allow the building up of large populations during the favorable summer months, and the hibernation of the larva under rather exposed conditions, which is very rare among the coccinellids probably causes a high winter mortality.

Judging from the evidence in the collections I have been able to examine, none of the other *Afissa* species occur in very large numbers, and none are known to do serious damage to cultivated plants.

2. AFISSA MACULARIS (Mulsant)

FIGURES 78, 153

E[pilachna] macularis MULSANT, 1850, p. 797.

Abdomen.—Abdominal lines subcomplete, subterminal, apex a flattened arc. Fifth segment, male, hind margin truncate or slightly convex; female, slightly triangular with the apical angle rounded off. Sixth segment, male, emarginate; female, evenly convex.

Male genitalia.—Penis seen in profile, 2.1 mm. long, slightly bent down near base and bent up near tip, which is a sharp point; gradually decreasing in thickness from base to tip. Seen from below, tube of almost equal width (0.3 mm.), orifice oval. Paramera length 2.2 mm., spoon-shaped with long, slender stem, curved down near base, widest part near apex 0.3 mm., covered with light blond hair on the apical, widened part. Sipho with 180° bend near base, straight from then on, widened just before end with orifice subterminal on side, small, covered with hairs.

Female genitalia.—Like those of *admirabilis,* but tergite X less deeply emarginate at apex. The plates with a gentle emargination at the middle of their inner edge which is absent in *admirabilis.*

Length.—7.5 to 9 mm.

Color and maculation.—Upper side light brownish red; pronotum spotless or black with a light edge all around (ab. *donckieri* Weise, 1912). Elytra each with six large black spots as indicated in figure 78. The spots are more elongate than those of *admirabilis,* particularly No. 1, which envelops the scutellum. Under side and appendages light, except metasternum, part of mesosternum, and basal part of abdomen dark in varying degrees. Pubescence light gray also on the black spots.

Type locality.—Nepal, Assam. That of ab. *donckieri* Weise, China, Yunnan Prov., Tali.

Material examined.—14 specimens: China, Szechwan Prov., Shin Kai Si, Mount Omei, alt. 4,400 feet, August 1921 (D. C. Graham, NM), ground form. Tibet (AMNH), ab. *donckieri.* India, Assam, Shillong, July 1945 (3 specimens, J. Unyal, D).

Remarks.—This species resembles rather closely some forms of *admirabilis* Crotch. The two species can be separated with ease by their genitalia, particularly the male ones. The penis of *admirabilis* shows the swelling in the middle, while that of *macularis* decreases uniformly in thickness from base to apex. Externally they can be distinguished by the elytral pubescence, which is uniformly gray in *macularis,* but black on the spots in *admirabilis.* Other criteria mentioned by Weise and Mader, such as the shape (more elongate for *macularis*), the punctation (finer with a dull surface for *macularis*), and the shape of the abdominal lines, are too variable or indefinite to be of much use.

3. AFISSA GRAYI (Mulsant)

FIGURES 6 B, 81, 107

E[pilachna] Grayi MULSANT, 1850, p. 774.

Abdomen.—Female, abdominal lines complete, reaching to within about one-fourth of hind margin of the first segment. Fifth segment, hind margin mildly convex, sixth segment with a narrow deep notch in the middle that reaches about halfway to the base of the segment (fig. 6 B, p. 26).

Female genitalia.—Of the *admirabilis* type with tergite X emarginate.

Length.—7.5 mm.

Color and maculation.—Brick red, pronotum spotless; elytra with six small spots each. No. 1 on the suture enveloping the largest part of the scutellum, No. 4 touching the margin and reaching to the epipleurae. No. 5 on the suture. No. 6 transverse. Under side, metasternum, part of mesosternum, and practically all the abdomen dark, rest light, appendages except tip of mandibles light.

Type locality.—Bengal.

Material examined.—2 females: Java, Tjibodas, Mount Gede, alt. 5,000 feet (Bryant and Palmer, NM).

4. AFISSA ALTERNANS (Mulsant)

FIGURES 6 A, 79, 105

E[pilachna] alternans MULSANT, 1850, p. 767.

Very similar to *A. grayi.* The chief difference is the absence of the notch in the sixth abdominal segment of the female (fig. 6 A, p. 26).

There are also differences in size, color, and maculation of the specimens before me.

Length.—9.5 mm.

Color and maculation.—Pronotum spotless, elytra with spots 1 and 2 united to form a fascia, which touches the base and is widened along the suture but leaves the scutellum light. Spots 3 and 4 also united.

Type locality.—Java.

Material examined.—2 females: Java, Buitenzorg, March 1909 (Bryant and Palmer, NM). China, Szechwan Prov.

Remarks.—*Epilachna alternans* and *grayi* were described as two separate species by Mulsant but later were united by Weise. Korschefsky (1933b, p. 301) called attention to the fact that although both species have very variable maculation, the fascia formed by spots 1 and 2 always touches the base in *alternans* but leaves most of it free in *grayi*. With the few specimens at my disposal, it is impossible to settle the matter definitely except to say that they belong definitely to two different species, which, if Korschefsky's diagnosis is correct and there are no other species involved, must be *grayi* and *alternans*. The presence of the notch in the fifth abdominal segment of the female in *grayi* and its absence in *alternans* seem the best way to tell the two species apart. The male genitalia of both species are as yet unknown.

The assumption of Korschefsky that *A. alternans* is restricted to Java does not seem correct, as the China specimen is apparently of the same species as the Java specimen.

5. AFISSA INSIGNIS (Gorham)

FIGURES 82, 152

Epilachna insignis GORHAM, 1892, p. 84.

Abdomen.—Abdominal lines subcomplete, subterminal; middle of first segment with the punctation much finer than in *admirabilis*. Fifth segment, male, hind margin truncate; female, slightly concave. Sixth segment, male, with distinct notch; female, very slightly emarginate.

Male genitalia.—Penis seen in profile, almost straight, slightly bent up near apex, 2.2 mm. long, with a few hairs on its upper side. Seen from below, a flattened tube ending in a blunt point, seam gradually slit open toward apex. Paramera 2.3 mm. long curved up near base, flattened, and widest (0.25 mm.) near apex. Rim of last third with rather long (about 0.4 mm.) light blond hairs. Sipho long and slender, curved through 180° near base.

Female genitalia.—Apex of tergite X truncate. Plates elongate, 0.80 mm. long, pointed at basal end, outer edge without an emargination.

Length.—10 to 11 mm. Shape nearly hemispherical.

Color and maculation.—Upper side brick red; pronotum with a transverse black spot of varying size. When fully developed it leaves only a narrow light margin. Elytra each with seven black spots arranged as in *Afissa admirabilis* with the humeral spot (No. 2) split into two separate spots. These spots are occasionally united as shown in figure 82, but more often they are separate. Pubescence light gray, dark on the spots. Under side mostly black in dark specimens (with side pieces of prothorax and mesothorax, the fifth and sixth abdominal segments and appendages light) mostly light reddish brown in light specimens (sides of metasternum and epipleurae where the marginal elytral spot reaches over, dark).

Type locality.—China.

Material examined.—10 specimens, (NM, MCZ) from China: Datchuian, May 10, 1939 (T. H. Cheng); Mokanshan, 1925-1929 (C. F. Wu); Szechwan Prov., Wenchuan, November-December 1934 (D. C. Graham); Kuanhsien; Anhwei Prov., Kiuhua Shan, September 1932 (G. Liu).

Remarks.—This is an easily recognized species. It differs from the preceding four species by the fact that the humeral spot is usually broken up into two separate spots, so that each elytron has 7 spots. This splitting of the humeral spot is indicated in some specimens of *admirabilis* by a strong emargination of that spot. The female genitalia are different from those of the preceding species chiefly in having the apex of tergite X not emarginate. There is also a difference in the shape of the plates. *A. insignis* is most closely related to *A. maxima,* from which it can be distinguished by the difference in maculation and the fact that the outer edge of the female plates shows no emargination.

6. AFISSA MAXIMA (Weise)

FIGURES 83, 204

Solanophila maxima WEISE, 1898b, p. 236.

Abdomen.—Abdominal lines complete, reaching to within one-third of the hind margin of the first segment, broadly curved. Fifth segment, female, hind margin subtruncate to slightly convex with a slight depression in the middle. Sixth segment, margin entire.

Female genitalia.—As in *admirabilis.*

Length.—12 mm. Heart-shaped and very convex.

Color and maculation.—Upper side red, pronotum with a transverse black spot. Elytra each with seven dark spots partly coalescent, arranged as in figure 83. Pubescence light reddish on the red parts, light gray on the dark spots. Under side and appendages light, sides of metasternum and tips of mandibles darkened.

Type locality.—Assam.

Material examined.—1 female: Northern India, Darjeeling, alt. 3,000-5,000 feet, June-September (L. V. Newton, PA).

Remarks.—This species, the biggest of all epilachnines, is recognized easily by its size and markings, and according to its female genitalia belongs in the *admirabilis* group. Weise called it most closely related to *E. deyrollii* Crotch, which must be based on a misjudgment.

II. FALLAX GROUP

Elytra with six to eight dark spots, length smaller than 6 mm. Separation of the *fallax* group from the *admirabilis* group seems to be based on more than size, as the female genitalia where they are known show a different structure. The genital plates (see figs. 208, 209, 211) have, however, various shapes, a fact that suggests that the group should be further subdivided. There is, however, not enough material to do this successfully.

No broad generalizations can be made about the variability of the spot pattern, as only a few specimens are available for each species. There are indications that a number of different species exist with only slightly different maculation, a state of affairs found very markedly also in the *flavicollis* group.

The male genitalia are diversified and permit in all known cases a clear separation of the species.

The group may be subdivided by the structure of the inner tooth of the tarsal claws. It is broad and touches the tooth of the other claw in the majority of the species of this group, while it is slender and separated from the inner tooth of the other claw in *manderstjernae* and *fenestrata.* The type of *siamensis* has no claws left, and so their structure is unknown.

The following key to the species of this group is based chiefly on the spot pattern. It would become useless if a great variability of the pattern within one species should be the rule. In that case probably only an examination of the genitalia would lead to a positive identification. The genitalia should be used to check the identification in any case.

1. Scutellar spot of elytra not on suture 2
   Scutellar spot on suture 4
2. Fifth spot free from suture ..... atypica
   Fifth spot on suture 3
3. Elytra each with 6 spots, head light, form oval ..... manderstjernae
   Elytra each with 7 spots, the seventh apical, head dark with a rectangular light spot, form elongate 15-guttata
4. Elytra each with 8 spots ..... siamensis
   Elytra each with 6 spots 5
5. Pronotum spotless 6
   Pronotum with a discal spot 7
6. Spots 1+2 and 3+4 or 4+3+5 forming fasciae or showing tendency toward this ..... gedeensis
   Spots rounded without tendency to form fasciae ..... nilgirica
7. Coarse elytral punctures obsolete, except near margin ..... fallax
   Coarse elytral punctures distinct everywhere 8
8. Pronotal spot broad covering more than half pronotum ..... mirabiloides
   Pronotal spot small or elongate 9
9. Pronotal spot reaching from base to apex of pronotum ..... bengalica
   Pronotal spot small, on disk only ..... maculicollis

7. AFISSA MANDERSTJERNAE (Mulsant)

FIGURES 90, 155, 208

Epilachna Manderstjernae MULSANT, 1853, p. 128.

Abdomen.—Abdominal lines complete, reaching to within about one-fourth of the hind margin of the first segment. Fifth segment, apical margin subtruncate in both sexes. Sixth segment, male, with an emargination; female, hind margin convex.

Male genitalia.—Penis seen from below, a tube closed until about the middle with a longitudinal seam, then opening gradually so that the orifice forms an elongate opening wedge-shaped toward the base with an oval apical margin. Penis gradually widening from base to apex, beyond the apex of orifice continued into a blunt point. Greatest width near apex just before it narrows abruptly to point, point slightly turned up, profile nearly straight. Paramera very thin, thread-like, width about 0.02 mm., length 0.6 mm., sparsely covered with hairs near apex. Sipho curved near base through about 180°, from then on only very slightly curved in the same direction. Near apex a sudden sharp right-angle turn outward, with the tube suddenly diminishing in thickness continuing for about 0.3 mm., tapering off into a very fine point.

Female genitalia.—Tergite X wide with mildly convex apex. Plates subquadratic with corners rounded, length 0.17 mm.; inside edges convex.

Length.—3.2 mm.

Color and maculation.—Upper side red, pronotum with a transverse spot; width just short of half the width of pronotum, elytra each with six spots. No. 1 not touching the suture, No. 5 on the suture. Under side light except metasternum and part of abdomen.

Type locality.—Asia.

Material examined.—12 specimens, all from India: Northern Bengal, Kurseong, June (PA); United Prov., Dehra Dun Distr., Chakrata, 8,000 feet, April 26, 1944; Dehra Dun, April 12, 1944 (J. Unyal, D); Mussoorie, Landour, July 17, 1927 (R. Dudgeon, NM).

Remarks.—The color of this species is somewhat variable. In some specimens the pronotum is spotless, the elytral spots small, No. 5 almost disappearing and not quite touching the suture, and the under side practically completely light. In other specimens the pronotal spot is fully developed, the elytral spots large, No. 5 a joint round spot on the suture, and the under side almost completely dark.

8. AFISSA QUINDECEMGUTTATA, new species

FIGURES 93, 162, 211

Abdomen.—Abdominal lines complete, reaching to within one-sixth of the hind margin of the first segment. Fifth segment, male, hind margin truncate; female, with a slight median process. Sixth segment, male, hind margin emarginate; female, convex.

Male genitalia.—Most easily recognized by the profile of its penis, by which it differs from all the other known species (fig. 162). Paramera very slender, slightly thickened toward base and apex; sipho possibly longer than indicated in the figure, as the tip is broken off in the type.

Female genitalia.—Tergite X with convex apical margin. Plates roughly oval-shaped, widest in the middle and more broadly rounded at the apical than at the basal part; apex slightly emarginate; a depression at the inner edge near the base. The whole apical margin double. Length of plates 0.33 mm., greatest width 0.25 mm.

Length.—4.9 mm.

Color and maculation.—Upper side reddish brown, head black except appendages and a rectangular piece in the middle of the base. Pronotum black with the side margin light. Elytra each with six black spots as shown in the figure, No. 6 with a deep emargination in front as if it might have been due to the confluence of two spots, No. 3 on the suture. The two lobes are of equal size, which is

distorted in the figure. In addition to the six spots, also the tips of the elytra are dark. Under side black, including epipleurae, which, however, have a narrow light outer margin. Appendages light except the basal two-thirds or three-fourths of the femora, which are dark.

Material examined.—Type: U.S.N.M. No. 57137, China, Szechwan Prov., west of Yachow, 6,000 feet, August 8-12, 1923 (D. C. Graham).

Paratype (female): Same locality, alt. 2,000-8,000 feet, June 16-20, 1923.

9. AFISSA SIAMENSIS, new species

FIGURES 92, 163

Abdomen.—Abdominal lines complete, reaching to within one-sixth of the hind margin of the first segment. Fifth segment, male, hind margin truncate. Sixth segment, slightly emarginate.

Male genitalia.—Penis seen in profile, gradually diminishing in thickness from base to apex. At about 0.8 mm. from base a sharp upward bend; the apex a sharp point about 0.3 mm. from this bend. Seen from below, closed tube of about 0.2 mm. width until just before the bend, then opening up and the walls continuing as low lateral ridges. Apex a blunt point. Paramera very thin, about 0.03 mm. wide along their whole length, about 0.85 mm. long, gently curved down with sparse hairs at apex. Sipho with a sharp thorn at apex.

Length.—4.2 mm.

Color and maculation.—Upper side reddish brown, pronotum lighter at the sides with two dark spots, one on each side of the middle. Elytra each with eight dark spots. Nos. 1 and 5 on the suture, No. 7 rounded like the other ones between No. 6 and the margin, No. 8 subapical. Under side and appendages light brown, metasternum and middle of basal segments of abdomen dark. Pubescence light gray, black on the spots.

Type.—U.S.N.M. No. 57138, Siam, Nan, January 27, 1928 (Cockerell).

Remarks.—This species has the full complement of eight spots on each elytron, all well-developed and separate. This seems to be the maximum number occurring in the genus *Afissa*.

10. AFISSA FALLAX (Weise)

FIGURES 84, 151, 205

Solanophila fallax WEISE, 1908, p. 219.

Abdomen.—Abdominal lines complete, evenly rounded, reaching to within about one-fifth of the hind margin of the first segment.

Fifth segment, male, hind margin slightly convex; female, more pronouncedly convex. Sixth segment, male, truncate to moderately convex; female, narrower and strongly convex.

Male genitalia.—Penis, profile about 0.2 mm. before the point sharply bent upward through more than 90°. Seen from below, trough of approximately equal width (0.2 mm.), flatter toward the apex, length 1.2 mm. Tip bifurcate. Paramera slender, slightly curved, length about 1.1 mm., only very slightly dilated at apex, apical third with long hairs (0.3 to 0.4 mm. long). Sipho bent almost 180° near base, and through about 90° outward near tip. Orifice oval, subterminal on side; a sharp ridge on the opposite side.

Female genitalia.—Plates with the inner edge straight and forming the base and longest side of an isosceles triangle with the apex rounded off. Tergite X with apex strongly convex.

Length.—5.5 mm.

Color and maculation.—Upper side brick red. Pronotum with an elongate black spot on the middle line beginning just after the front margin and reaching to about the middle, widest near the front. Elytra each with six rounded spots, Nos. 1 and 5 on the suture and forming complete circles with their counterparts on the other elytron. No. 4 touching the margin. No. 1 touching the apex of scutellum. Under side light brown, the breast darker.

Type locality.—Borneo, Kina Balu.

Material examined.—4 specimens: Borneo, Kina Balu, 1,500 meters (NM).

Remarks.—The specimens bear the label *E. zeylanica* Crotch and would agree equally well with Crotch's description of that species. "Punctation fine, the coarser punctures only apparent at the sides" applies also to the present specimens. Korschefsky (1933a) compared the types of the two species and came to the conclusion that they are closely related, but because of the poor condition of the type of *zeylanica* he could not decide the question whether the two species are identical. Without a comparison of the genitalia, which Korschefsky did not make, no reliable decision would be possible. Should the two species be identical, Crotch's name would, of course, have priority. In the meantime, there is little doubt that the present specimens, which come from the type locality of *fallax* and agree exactly with Weise's description, are *fallax* Weise. Weise (1923b) reports the species also from Formosa, where it is smaller in size. Without a comparison of the genitalia, however, caution is indicated in assuming that this is the identical species.

A. fallax can easily be recognized by the forked penis with a sharp upward bend at the tip. Anything similar is not known in any other species.

11. AFISSA GEDEENSIS, new species

FIGURES 94, 94A, 161

Abdomen.—Abdominal lines complete, evenly rounded, reaching to within one-fifth of the hind margin. Fifth segment, male, hind margin subtruncate. Sixth segment, slightly emarginate.

Male genitalia.—Penis seen from below, a flattened tube, about 0.25 mm. wide, split open along its whole length, slightly constricted in the middle. Borders of the slit slightly raised, orifice very elongate, diamond-shaped. At the apex of the orifice a narrow raised ridge begins, continuing and curving upward beyond the rest of the penis with approximately equal width. Profile (length 1.5 mm.) straight in basal half, then gradually curved up in a feeble arc. Paramera wirelike, 0.9 mm. long, less than 0.1 mm. wide, covered with light blond hairs (about 0.2 mm. long) on their apical third. Sipho bent through 180° near base and less strongly in opposite direction near apex, ending in straight tip. Orifice subterminal on outside.

Length.—4.6 to 4.8 mm.

Color and maculation.—Upper side red, pronotum a little more yellowish, spotless. Elytra each with six black spots, which may partly coalesce to form transverse fasciae. Least coalescent form: Spot 1 on the suture and touching the base, enveloping the scutellum completely but leaving it red. Only very narrowly separated from No. 2, which is transverse, touches the base, and practically reaches the margin in the humeral angle. Spots 3 and 4 united, but with a constriction that shows that the narrow fascia formed by them, which reaches from the margin to within 0.7 mm. from the suture, is composed of two laterally widened spots. Spot No. 5 on the suture forming with its counterpart an almost circular spot. No. 6 laterally widened, not quite reaching the margin and 0.3 mm. distant from the suture. Its axis perpendicular on the margin. This pattern is modified in the following way: Spots 1 and 2 form a continuous fascia of almost equal width with straight hind margin and touching the base along its whole length. The fascia 3+4 is continuous without a constriction in its middle. Spots 5 and 6 are unaffected. In the most-developed specimen the fascia 3+4 is joined to the sutural spot 5, so that a fascia results which reaches continuously from margin to margin with a V-like notch in the middle.

Material examined.—Type: U.S.N.M. No. 57139, from Java, Tjibodas, Mount Gede, April 20, 1909 (Bryant and Palmer).

3 paratypes: From same locality as type, with same data as type (1 specimen) and with altitude of 5,000 ft. but without date (1 specimen).

12. AFISSA BENGALICA, new species

FIGURES 85, 154

Abdomen.—Abdominal lines complete, rounded, subterminal. Fifth segment, male, hind margin truncate. Sixth segment, slightly emarginate.

Male genitalia.—Penis a flattened tube about 1.0 mm. long, closed for slightly less than half its length, the apical end completely open, the middle of this part a semitransparent membrane. Apex suddenly constricted into a point, which is slightly curved up. Paramera slender, 0.75 mm. long, about 0.06 mm. wide, clothed with long (0.2 to 0.3 mm.) blond pubescence on apical third. Sipho curves more than 180° near base, then straight. Orifice oval, subterminal on side.

Length.—4.9 mm.

Color and maculation.—Upper side brownish red; pronotum with a longitudinal black spot reaching from the front edge to the scutellum, widest near the front. Scutellum black; elytra each with six black spots, Nos. 1 and 5 on the suture forming each one spot with their counterparts on the other elytron. No. 2 touching the humeral angle, No. 4 the margin. Both coarse and fine punctures distinct all over the elytra, the coarse punctures deep and prominent; pubescence light gray, dark on the spots. Under side dark except head, prosternum, and epipleurae. Legs partly dark. Mouth parts and antennae light except apex of mandibles and club of antennae, which are dark.

Type.—Academy of Natural Sciences of Philadelphia, India, northern Bengal, Kurseong, June (Mason).

Remarks.—This species is evidently closely related to *Solanophila nilgirica* Weise (1908, p. 219) and might be identical with it if that species should prove to be very variable. *A. nilgirica* differs from *bengalica* by having the pronotum spotless, scutellum not dark, and the extension of the last spot pointing at the fifth, whereas in *bengalica* it points far behind the fifth. *A. nilgirica* has the under side mostly testaceous. Sicard (1912c, p. 131) described a variety *maculicollis* of *nilgirica* from Formosa (see *A. maculicollis*). *A. bengalica* would resemble this variety more than the ground form of *nilgirica*. However, it would be dangerous to conclude anything about the relation-

ship of two forms so distant geographically just from superficial resemblance, without a comparison of the genitalia.

Afissa bengalica also resembles superficially *Afissa fallax* (Weise). The two can easily be separated by the coarse punctation of the elytra, which is pronounced everywhere on *bengalica* but obsolete except near the margin on *fallax*. The male genitalia of these two species are entirely different.

13. AFISSA MIRABILOIDES, new species

FIGURE 86

Abdomen.—Abdominal lines complete, subterminal, rounded. Fifth segment, male, hind margin truncate. Sixth segment, moderately convex.

Male genitalia.—Destroyed except sipho, which is similar to that of *bengalica.*

Length.—4.5 mm.

Color and maculation.—Upper side brownish red, head with a darker transverse bar; pronotum, disk dark with the sides and the lateral parts of the base lighter. Elytra each with six black spots arranged as in *bengalica* but larger. Nos. 1 and 5 on the suture. Under side, metasternum black, abdomen partly dark, femora slightly darkish, the rest light.

Type.—U.S.N.M. No. 57140, from China, Szechwan Prov., Hua Yin Shan, 70 miles north of Chungking, alt. 2,500 feet, July 5, 1933 (D. C. Graham).

See remarks under *A. maculicollis* (Sicard).

14. AFISSA MACULICOLLIS (Sicard)

FIGURE 85A

Solanophila nilghirica var. *maculicollis* SICARD, 1912c, p. 131.

Abdomen.—Abdominal lines complete, subterminal, rounded. Fifth segment, female, wide, hind margin convex. Sixth segment, convex.

Female genitalia.—Genital plates flattened isosceles triangles with the inside edge as the base and the top of the triangle rounded. They resemble those of *A. fallax* (Weise) but are more stretched. Tergite X damaged in the one specimen I could examine.

Length.—4.9 mm.

Color and maculation.—Very similar to *bengalica,* with the following differences: The pronotum has only a small rounded dark spot

just before the middle, scutellum light; under side and appendages light with only the metasternum dark.

Type locality.—Formosa.

Material examined.—1 female, Formosa, Urai, April 10, 1929 (K. Sato, NM).

Remarks.—This species was regarded as a variety of *A. nilgirica* (Weise) by Sicard. He characterized it by the following differences: "Form a little more elongate, pubescence a little denser, pronotum on the disk marked with a black spot. Four specimens from Formosa." In view of the great geographical separation of the type localities of *nilgirica* and *maculicollis,* and the fact that in *Afissa* distinct species are often marked by only slight differences in appearance, it seems safer to regard *maculicollis* as a distinct species until an examination of the male genitalia can settle the question.

15. AFISSA NILGIRICA (Weise)

Solanophila nilgirica Weise, 1908, p. 219.

According to Weise's description this species is very similar to the preceding three species. It differs from them by a spotless pronotum and the fact (on which Weise puts some stress) that the sixth elytral spot is elongated and points directly to the fifth spot. In the other three species (and in *fallax*) the prolongation of the sixth spot would meet the suture well behind the fifth.

The status of the four species *bengalica, nilgirica, maculicollis,* and *mirabiloides* must be considered very uncertain until more material will make a comparison of both male and female genitalia of all four forms possible. They are very closely related, and all four have the inner tooth of the tarsal claw widened and touching that of the other claw. *A. bengalica* and *mirabiloides* are distinguished by the shape of the hind margin of the sixth abdominal segment, which is emarginate in *bengalica* and convex in *mirabiloides.* If there should be no greater variability within each species of the maculation, the pronotal pattern would be an easy means of separating the species.

A. fallax (Weise), which also has the same spot pattern, can, however, easily be separated from *bengalica* and its associates by the coarse punctation of the elytra, which is pronounced everywhere on *bengalica,* etc., but obsolete except near the margin on *fallax.* The male genitalia of these two species are entirely different. The female genitalia of *fallax* and *maculicollis* are similar but more stretched in *maculicollis.*

Type locality.—India, Nilgiri Hills.

16. AFISSA ATYPICA, new species

FIGURES 91, 156

Abdomen.—Abdominal lines complete, subterminal, rounded. Fifth segment, male, hind margin slightly convex. Sixth segment, convex.

Male genitalia.—Penis seen from below, 0.8 mm. long, flattened tube, width about 0.3 mm., middle split open with the edges about 0.04 mm. apart, the apex of this slit about 0.2 mm. from the end point of penis, and the sides connected at the apex by a very narrow threadlike transverse bridge, which has a width of considerably less than 0.01 mm. Paramera flattened, 0.1 mm. wide, 0.7 mm. long, slightly curved downward near base. Apical third sparsely covered with hairs. Sipho curved 180° near base, curved into the opposite direction into a wide hook near apex.

Length.—4.4 mm. Mandibles with apical and two lateral teeth of about the same size.

Color and maculation.—Upper side reddish brown. Pronotum with a narrow elongate spot in the middle. Elytra each with six dark spots, none touching the suture. Nos. 1 and 2 near the base not very distinct. Nos. 3 and 4 forming with their counterparts on the other elytron a nearly straight transverse band. Both transversely widened, No. 3 particularly so. No. 4 touches the margin. No. 6 hardly any farther back than No. 5, near the margin but not touching it. The inner edges of Nos. 3 and 5 equally distant from the suture. Pubescence light gray except on the spots. Under side brown.

Type.—U.S.N.M. No. 57141, from India, northern Bengal, Kurseong, June.

Remarks.—This is the only species with six elytral spots that does not have the fifth spot on the suture (except *maxima,* with which it cannot possibly be confused). It also stands out by the fact that spots Nos. 5 and 6 are about equally far back, whereas usually No. 6 is considerably farther back. This distinguishes it immediately from all the species of *Epilachna* with 6 spots. It is very doubtful whether *atypica* actually belongs to the *fallax* group.

III. FLAVICOLLIS GROUP

Elytra each with five spots or less, which occasionally may coalesce. If a discal fascia is formed, it is not V-shaped near the suture but goes straight across. The female genitalia are of the *flavicollis* type. (fig. 206) with the plates very elongate and tergite X with a very convex but simple hind margin.

This group is separated from the preceding one by the fact that the basal spot pattern (fig. 88) has five spots on each elytron. From the *complicata* and *szechuana* groups, which have this feature in common, it can easily be distinguished by the shape of the female genitalia. In these two last groups the abdomen is often modified or the elytra have cavities for the reception of the tips of the femora, features never found in the *flavicollis* group.

Because of lack of long series we know very little about the variation of the maculation. In *flavicollis,* the only species for which a fair series is available, the spot pattern does not show much variation. On the other hand, there are different species with practically the same spot pattern. In such cases the male genitalia are excellent criteria for recognizing the species. They are usually quite differentiated and permit in all known cases a clear-cut recognition of the species. The structure of the mandibles is occasionally also of use.

Afissa lugubris, which shows quite a different spot pattern (seven light spots on a dark background on each elytron), has been included in this group because of the great similarity of the female genitalia.

The *flavicollis* group contains about 20 species of small to moderate size (length 4 to 8.5 mm.). The figures of the spot patterns and those of the male genitalia will serve better for the identification of the species than any key. Because the male genitalia of a number of important species are still unknown, no attempt has been made to arrange the species of this group into a natural sequence.

17. AFISSA QUADRICOLLIS, new species

FIGURES 87, 159, 209

Abdomen.—Abdominal lines subterminal, incomplete, the inner margin gently curved, the apex running almost parallel to the hind margin of the segment for a short interval, then suddenly curved about a right angle and the outer part nearly parallel to the side margin of the segment, big circular punctures in middle of segment, diminishing in size toward apex. About the middle of the segment the abdominal line loses itself. Fifth segment, male, hind margin subtruncate, mildly emarginate; female, slightly convex. Sixth segment, male, mildly emarginate; female, convex.

Male genitalia.—Penis seen from below, a flattened tube split open along the middle and ending in blunt point; seen in profile, almost straight. Paramera wider than usually in the *flavicollis* group, 0.7 mm. long, greatest width 0.15 mm., covered at the periphery of more than the apical half with long (about 0.4 mm.) blond hairs.

Sipho curved strongly at base, then gently until a point where it is bent sharply by about 180°. Before this bend the width is about uniform, 0.07 mm.; at the bend it decreases suddenly to about 0.03 mm. and curved into more than a semicircle.

Female genitalia.—Most like those of the *admirabilis* group but tergite X with an even convex hind margin, not so narrow as in the *flavicollis* group.

Length.—5.0 to 6.0 mm. Mandibles with one lateral tooth. Epipleurae with shallow cavities for the reception of the tips of the middle and hind femora.

Color and maculation.—Upper side brownish or yellowish red; pronotum with four spots in a transverse row, the inner ones big, the outer ones small. Often the outer and inner spots joined together (as in fig. 87); occasionally the two inner ones almost coalescent, but not in any of the specimens seen by me to such an extent that a continuous band is formed. Elytra with five spots, No. 2 crescent-shaped, emarginate by the callus with the horns pointing outside. Under side light or only slightly darkened.

Material examined.—Type: U.S.N.M. No. 57142, China, Chekiang Prov., Hangchow, September 6, 1919 (H. F. Loomis).

12 paratypes from type locality and Kiang-su Prov., Soochow, 1925-1929 (C. F. Wu).

Remarks.—This species, because of the crescent-shaped humeral spot bears resemblance to *A. 10-maculata* Redtenbacher. However, the fact that the pronotum has consistently four spots instead of three and that these specimens are found very far from the type locality of *10-maculata* makes it likely that we are dealing here with an entirely different species. It is easily recognized by the peculiar shape of the sipho. The genitalia have no resemblance to those of a species identified as *elvina,* which is supposed to be closely related to, if not identical with, *10-maculata* Redtenbacher.

18. AFISSA FLAVICOLLIS (Thunberg)

FIGURES 88, 158, 206

C[occinella] flavicollis THUNBERG, 1781, p. 18.

Abdomen.—Abdominal lines subcomplete or complete reaching in a regular arc to within one-third to one-fourth of the hind margin of the first segment. Fifth segment, male, hind margin truncate; female, segment wider and hind margin convex. Sixth segment, male, subtruncate; female, broadly convex.

Male genitalia.—Penis seen in profile, almost straight, 1.05 mm.

long, slightly compressed at about basal third and very slightly bent up at tip. Seen from below, flattened tube about 0.13 mm. wide near base and widening slightly toward apex. Closed at base and the seams gradually diverging. Penis ending in two sharp adjacent points, but slightly divergent. Paramera 0.84 mm. long, slender subcylindrical, about 0.05 mm. wide in middle; apical third covered with long (about 0.2 mm.) hairs arranged in two opposite rows. Sipho moderately curved near base, total bend about 90°, about 0.25 mm. before tip bent sharply in the opposite sense, thinner in the bend.

Female genitalia.—Tergite X elongate with strongly convex apical edge. Plates elongate, becoming narrower toward apex, stylus terminal, pigment chiefly near apex and on outer edge. Apical third sparsely covered with long, bristlelike hairs.

Length.—5.3 to 6.5 mm. Mandibles (fig. 1 E) with a tridentate apical tooth and two prominent lateral teeth of about the same size as the apical tooth. Middle tooth on inside usually with two weak dentules. Elytra with both coarse and fine punctures pronounced.

Color and maculation.—Upper side red. Pronotum often yellow, particularly at the sides. Elytra each with five rounded black spots. Neither No. 1 nor No. 3 reaching the suture, No. 4 touching the margin or almost touching. Pubescence yellowish, dark on the spots. Under side all light on the specimens from India, metasternum, abdomen, and mandibles partly dark on the Philippine specimens.

Type locality.—East Indies.

Material examined.—33 specimens (NM) from the following localities: India, Mormugao, Goa, June 1925, 1924-1926 (J. C. Bridwell, NM). Sumatra: Dolok Silau, 1937 (Mann, NGS-SI Exp., NM). Island of Penang (Baker). Philippine Islands (Baker, except those noted): Luzón Island, Mount Banájao, Mount Maquíling; Benguet Prov., Irisan, June 1903 (McGregor); Nueva Ecija Prov., Minuli (McGregor); Mindanao Island, Surigao, Butuan, Iligan, Zamboanga; Samar Island; Biliran Island; Basilan Island; Sulu Islands, Jolo, July 1924 (A. Duyag); Bho, Paete. Borneo: Sandakan (Baker).

Remarks.—One female specimen from Candy, Ceylon, has the mandibles of *flavicollis* but the pronotum with a dark discal spot as in *11-spilota*. The color of this specimen is a much deeper red than that of the other specimens of *flavicollis*.

This species, occurring from India to the Philippines, seems to be one of the most widely distributed species of *Afissa*. It is so similar in external appearance to the next three species that a separation according to external characters only is very difficult. Those

characters given in the literature to distinguish the species, like the punctation of the elytra, the exact position of the elytral spots, the shape of the abdominal lines or the pubescence of the elytra, are often either too variable or too uncertain for clear recognition of the species. The account of these species in the literature is very confusing, and although there seems to be every reason to believe that *Afissa flavicollis* has been recognized here correctly, the identity of the other three species is less certain because of the small number of specimens available and because of the conflicting statements made by various authors. The structure of the mandibles is an excellent character in addition to the genitalia, which unfortunately are only partly known.

A. flavicollis is distinguished from the three other species by the presence of the two large lateral teeth (fig. 1 E) on the mandibles. The male genitalia are quite different from those of *coccinelloides* (fig. 168) and *dumerili*. Those of the fourth species are unknown. The female genitalia seem to be very similar in structure to those of *11-spilota*, but different from those of *dumerili*, while those of *coccinelloides* are not yet known.

A. dumerili and *11-spilota* have only one lateral tooth (fig. 1 F) and *A. coccinelloides* none. It would be interesting to know whether differences in food habits correspond to the differences in mandible structure of these otherwise so similar species.

19. AFISSA DUMERILI (Mulsant)

FIGURES 1 F, 212

E[pilachna] Dumerili MULSANT, 1850, p. 801.

This and the two following species are very similar in appearance to *Afissa flavicollis*. The male genitalia of *A. undecemspilota* are unknown. Those of the other three species permit easily a definite separation. The other properties are so much alike that it seems best to characterize them by their differences from *flavicollis*.

Abdomen.—Like *flavicollis* except that the abdominal lines are somewhat wider and slightly asymmetric, steeper on the outside.

Male genitalia.—Penis seen from below, length 1.45 mm., split for its whole length. The two parts are touching each other about the middle. The space between them on the basal half is very elongately diamond-shaped, maximum separation 0.07 mm. Beyond the middle the two parts diverge widely, each ending in a blunt point with a small outward hook. Profile nearly uniformly wedge-shaped. Paramera about 0.8 mm. long, slightly bent near base, flattened and subparallel

for the apical two-thirds, rim of apical third with rather long (max. 0.4 mm.) hairs. Sipho about 5 mm. long, bent through 180° near base, thickened at apex, orifice terminal.

The *female genitalia* (fig. 212) have the plates capable of being folded lengthwise. In the figure one side is open, the other folded. The shape of the plates is more triangular and approaches *fallax* (fig. 205) in this respect.

The *mandibles* differ from those of *flavicollis* by having only one lateral tooth considerably smaller than the apical one, which is tridentate as in *flavicollis*. This type of mandible structure is found in many other species of *Afissa*. The claws have their inner parts touching like figure 2 G.

The *maculation* in both species is very similar, and it is not certain whether the observed differences are significant. Spot 1 is less close to the base, No. 3 is about as close to the suture as No. 1. No. 4 is free from the margin, and No. 5 is a little closer to the suture than it is to the margin. The pubescence is longer and denser and whitish gray instead of yellowish blond as in *flavicollis*.

Type locality.—East Indies.

Material examined.—15 specimens: India, northern Bengal, Kurseong, June (2 specimens, NM, PA); Assam, Shillong, July 1945 (13 specimens J. Unyal, D).

20. AFISSA UNDECEMSPILOTA (Hope)

FIGURE 88A

Coccinella 11-spilota HOPE, 1831, p. 31.
E[pilachna] undecim-spilota MULSANT 1850, p. 799.
Epilachna undecim-spilota CROTCH, 1874, p. 81.

There has been some confusion about this species. Hope's original description is: "Rubra, thorace margine testaceo elytrisque maculis decem notatis. Long. lin. 2-1/2 lat. 1-1/4." Mulsant (1850) gave a more detailed description, according to his statement from the original type which had been sent to him by Hope. Crotch (1874) questioned this and claimed Hope's *11-spilota* to be identical with Mulsant's *stephensii,* stating that the type is in the British Museum. The description he gave—"Oval, black, head and legs red, sides of thorax yellow; elytra dull red, each with six black spots of which two are common; etc."—does not agree at all with that of Hope, who gave the color as red instead of black. It seems likely, therefore, that Mulsant saw the original type, which subsequently may have been confused with another specimen.

The two female specimens before me agree fairly well with Mulsant's description. They have the mandible structure of *dumerili* (only one lateral tooth), but the structure of the female genitalia is that of *flavicollis*. The elytral pubescence is light gray as in *dumerili;* otherwise the maculation is as in *flavicollis* except for the pronotum, which has a discal dark spot which is transverse in the Bengal and round in the Siam specimen. Knowledge of the male genitalia is needed to clear up the remaining uncertainties about this and the preceding species.

Type locality.—Nepal.

Material examined.—2 females (NM): India, northern Bengal, Kurseong, June. Lower Siam, Trong (W. L. Abbott).

21. AFISSA COCCINELLOIDES, new species

FIGURES 89, 168

Abdomen.—Abdominal plates complete, otherwise very similar to *flavicollis*. Fifth segment, male, truncate to emarginate. Sixth segment, subtruncate.

Male genitalia.—Not at all similar to those of *flavicollis*. Penis seen from below, flattened tube about 0.25 mm. wide, about equal width throughout; split in middle, the seams touching at apex, widest apart at about a quarter of the length. Tube ending into two long widely divergent points, slightly curved upward. Profile, lower edge approximately straight until just before apex; upper edge with a longitudinal ridge approximately in middle; greatest width about 0.45 mm. Paramera 0.85 mm. long, much shorter than penis, slightly curved down, with long hairs (0.4 mm. long) on apical third. Sipho long, bent in semicircle near base, from then on straight; tip widened.

Length.—6.2 mm. Mandibles (fig. 1 G) without lateral teeth and without dentules; apical tooth bifid.

Color and maculation.—As in *flavicollis*. Pubescence rubbed off on the type.

Type.—U.S.N.M. No. 57143, Borneo, Brunei.

22. AFISSA INCAUTA (Mulsant)

FIGURE 224

E[pilachna] incauta MULSANT, 1850, p. 803.

Abdomen.—Abdominal lines subcomplete, reaching to about one-fourth of the hind margin of the first segment. Fifth segment, male, truncate. Sixth segment, emarginate.

Male genitalia.—Penis seen in profile, 0.95 mm. long, bent up gently at about a third of its length and again just before it ends in a sharp point; penis flattened, thickness in middle less than 0.1 mm. Seen from below, a flattened tube widening slightly from the base to about two-thirds of its length, where it has its maximum width (0.33 mm.). There is a seam along the middle of the tube; orifice elongately diamond-shaped. Beyond the orifice there is a narrow median ridge, which is continued curving upward into the terminal point. Paramera 0.70 mm. long, slightly curved down at base, of nearly equal width (about 0.08 mm.), covered with blond hairs on practically their whole length. These are densest and longest (0.3 mm.) near the apex. Sipho bent through 180° near base and less strongly in opposite direction near apex (as in fig. 161). Orifice subterminal on outside.

The structure of the genitalia of this species is very similar to that of *A. gedeensis* (see fig. 161), so much so that a much closer relationship between the two species must be assumed than is suggested by the external appearance alone. The genitalia, however, are sufficiently different to leave no doubt that two distinct species are involved. The chief differences are: The size of the genitalia of *incauta* is considerably smaller than for *gedeensis,* even though the body size is larger. Seen in profile, the penis of *incauta* is curved up at about one-third of its length, whereas in *gedeensis* it is curved in the apical half.

Length.—5.5 mm. Tarsal claws as in figure 2 G.

Color and maculation.—Upper side yellowish red, head and pronotum spotless, yellowish, elytra red, each with five black spots. Nos. 1 and 3 on the suture, the former starting at about two-thirds the length of the scutellum, No. 4 on the margin. Average diameter of spots about 0.8 mm. Pubescence yellow, but dark on the spots. Under side light except the tips of the mandibles and the sides of the metasternum, which are darker.

Type locality.—Java.

Material examined.—1 specimen, Sumatra, Pagaralam (Brues, MCZ).

Remarks.—This specimen agrees well with Mulsant's description of *Epilachna incauta.* It can be recognized among the species with five elytral spots by the fact that spots Nos. 1 and 3 are on the suture. Crotch (1874, p. 82) mentions specimens having the spots united to form basal and medial fasciae. He may have had other species such as *gedeensis,* the close relationship of which with *incauta* has already

been mentioned. The form of *gedeensis* with the elytral spots unconnected has, however, six spots on each elytron.

23. AFISSA EXPANSA, new species

FIGURES 99, 160

Abdomen.—Abdominal lines complete, reaching to within one-fourth of the hind margin of the first segment. Fifth segment, male, hind margin truncate; female, convex and wider. Sixth segment, male, entire, subtruncate; female, convex.

Male genitalia.—Penis seen from below, a straight tube split open in the middle; length 0.65 mm., width 0.20 mm. The side margin is sharply folded in and leaves a longitudinal slit of about 0.04 to 0.06 mm. width in the middle. The penis ends in two sharp points slightly turned up. The upper wall of the penis is a semitransparent membrane. Paramera 0.45 mm. long, somewhat widened toward apex, maximum width slightly less than 0.1 mm.; rim of apical half covered with long (0.2 mm.) light-gray hairs. Sipho short (1.2 mm. long), nearly straight until close to apex where it has a sharp bend. Seen from the outside of this bend, sipho suddenly narrowed at the bend, the tip wider again; orifice round, terminal.

Female genitalia.—*A. dumerili* type. The plates folded and pigment lacking at the inner edge, length about 0.65 mm.

Length.—4.4 to 4.6 mm.

Color and maculation.—Upper side light reddish brown; head light to mostly dark. Pronotum with a big transverse spot, leaving only a narrow margin of the pronotum light in the darker specimens or a broad margin in the lighter ones. Elytra each with five large spots, which may partly coalesce. Spot 1 longitudinal, touching or almost touching base and suture, but leaving the scutellum light; No. 2 on the callus practically touching base and side margin. Spot No. 3 transverse, No. 4 practically touching the margin, in some of the specimens, including the type (fig. 99), 3+4 united to form a transverse fascia reaching from margin to suture. Spot 5 laterally widened in the darker specimens, practically touching the margin but not quite reaching the suture. Pubescence light gray, dark on the spots. Under side and appendages light with varying amounts of dark. In the lightest specimen only the metasternum and the abdomen darkish. In the darkest one metasternum and mesosternum and most of abdomen and femora black.

Material examined.—Type: U.S.N.M. No 57144, China, Szechwan Prov., Hua Yin Shan, 70 miles north of Chungking, alt. 2,500 feet, July 5, 1933.

7 paratypes with the same data; 1 female, near Muping, 7,000-13,000 feet, July 6, 1929. (All specimens coll. D. C. Graham.)

24. AFISSA BICRESCENS, new species

FIGURES 96, 166, 210

Abdomen.—Abdominal lines subcomplete, subterminal, slightly unsymmetrical, outer part less curved than inner. Fifth segment, male, hind margin slightly convex; female, more strongly convex. Sixth segment, male, entire; female, hind margin more convex.

Male genitalia.—Penis seen from below, straight, length about 0.5 mm., somewhat flattened tube, slit open lengthwise and ending in a split point. Width 0.11 mm. Profile straight, slender wedge with the point very slightly tilted up; upper side flat. Paramera slender, length 0.3 mm., apex clothed with sparse long hairs (up to 0.2 mm. long). Sipho short, about 0.8 mm. long, a slight bend at about one-third, from then on practically straight to tip. Orifice oval on outside, just before tip.

Female genitalia.—As in *dumerili.* Length of plates about 0.25 mm.

Length.—4.0 mm.

Color and maculation.—Upper side light brownish red, head with a small black spot on each side next to the eye in the male, with a heart-shaped black spot reaching almost from eye to eye in the female. Pronotum with disk black and a narrow light margin all around, elytra with five black spots arranged 2, 2, 1, as in *flavicollis,* but greatly modified in shape. No. 1 elongate, touching the base and extending along the suture, which it touches until it ends in a sharp point. No. 2 crescent-shaped with the horns pointing inward and practically touching No. 1, so that only a narrow oval spot between them remains light. No. 3 also crescent-shaped, but the horns pointing back, touching the suture and joined to No. 4, which touches the margin. No. 5 large, reaching practically from suture to margin. Pubescence light blond, dark on the spots. Under side mostly dark. Prosternum and parts of abdomen light as usual in this group; mouth parts except tips of mandibles, epipleurae, and legs, light. Femora with black spot in middle.

Type and one paratype.—U.S.N.M. No. 57145, China, Szechwan Prov., Hua Yin Shan, 70 miles north of Chungking, alt. 2,500 feet, July 5, 1933 (D. C. Graham).

25. AFISSA ELVINA (Mulsant)

FIGURE 172

Epilachna Elvina MULSANT, 1853, p. 122.

Abdomen.—Abdominal lines complete, rounded, reaching to within one-fourth of the hind margin of the first segment. Fifth segment, male, hind margin truncate, slightly emarginate; female, convex. Sixth segment, male, hind margin entire, convex, with long light blond hairs; female, convex.

Male genitalia.—Penis seen from below, a short tube with a seam along the middle, length 0.45 mm. less than the length of the whole penis. This is followed by a flat blade about 0.2 mm. wide and only very slightly elevated at the margins. Along the middle of this blade runs a very sharp ridge which passes a little beyond the apex of the blade and forms the point of the penis. Paramera nearly straight, shorter than penis, 0.65 mm. long, 0.1 mm. wide. On apical half rim clothed sparsely with long (max. 0.4 mm.) light blond hairs. Sipho curved sharply in a half circle near base, then straight and ending in a straight blunt point. Orifice terminal.

Female genitalia.—Plates elongate triangles, 0.95 mm. long, greatest width 0.27 mm. forming a sharp basal point. (More or less as in fig. 210.)

Length.—5.0 mm.

Color and maculation.—Upper side red. Pronotum with an elongated black spot in the middle and a smaller one on each side. Elytra with five large spots 2, 2, 1. No. 1 touching the suture, No. 2 with an emargination produced by the callus. Nos. 3 and 5 transversely widened, almost but not quite reaching the suture. No. 4 practically touching the margin. Pubescence dense, light gray, black on the elytral spots. Under side and appendages red except the metasternum, most of the abdomen, and the tip of the mandibles, which are dark.

Type locality.—Northern Provinces, India.

Material examined.—2 specimens: India, Mussoorie, Landour, July 17, 1928 (R. Dudgeon, NM).

Remarks.—These specimens agree completely with Mulsant's description of *elvina*. This species and *maculivestis* Mulsant (type locality, Tibet; Mulsant, 1853, p. 261) have been regarded as synonyms of *Epilachna 10-maculata* Redtenbacher (1844, p. 564; type locality, Kashmir). The material accessible to me is insufficient to test the correctness of this. The specimens would agree almost equally well with the descriptions of *maculivestis* and *10-maculata*, and only an examination of the genitalia of all three forms would decide the matter.

Korschefsky (1933b, p. 301) claimed *elvina* Mulsant to be a species distinct from *10-maculata* Redtenbacher and identified some specimens from Formosa with it. As this is very far from the type locality, this should be regarded with caution until it is backed by more evidence than can be obtained just from external appearance.

Afissa quadricollis resembles superficially this species, as it also has the emarginate humeral spot. It can, however, easily be separated by the fact that it has four spots on the pronotum instead of three. The male genitalia of the two species are entirely different.

26. AFISSA DECEMMACULATA (Redtenbacher)

Epilachna decemmaculata REDTENBACHER, 1844, p. 564.

Abdomen.—Abdominal lines complete, semicircular, reaching to about one-fifth of the hind margin of the first segment. Fifth segment, female, hind margin slightly convex. Sixth segment, strongly convex.

Female genitalia.—Shape as in figure 210.

Length.—4.8 mm.

Color and maculation.—Upper side light reddish brown. Pronotum with three black spots; the one in the middle roughly longitudinally diamond-shaped, closer to the front than the hind margin, the lateral ones rounded about one-fifth of the width from the side margins. Elytra with five black spots: No. 1 oval, well behind the scutellum, No. 2 crescent-shaped with the callus in the emargination; No. 3 transverse, not quite touching the suture, No. 4 oval, close to the margin but not touching it, No. 5 large, reaching almost from suture to margin. Surface opaque. Pubescence yellowish, with black on the spots. Under side, metasternum, the first three segments of the abdomen, and the tips of the mandibles dark, the rest including the appendages light reddish brown.

Type locality.—Kashmir.

Material examined.—2 specimens: India, Chabua, August 1943 (D. E. Hardy, NM); United Prov., Kumayun, Bhawaki, 5,000 feet, June 18, 1944 (J. Unyal, D).

Remarks.—This specimen agrees well with Redtenbacher's figure and his scanty description. It differs from the species here identified as *elvina* by being not quite so wide, having an opaque surface, while *elvina* has the elytra smooth and shiny and having yellowish rather than grayish pubescence. The elytra are compressed at the sides and have a distinct depression near their base. Though the two species are therefore distinct, the evidence as to which is which is much less definite.

27. AFISSA MYSTICOIDES (Sicard)

FIGURES 95, 164

S[olanophila] mysticoides SICARD, 1912b, p. 507.

Abdomen.—Abdominal lines subcomplete, evenly rounded, reaching to within a third of the hind margin of the first segment. Fifth segment, male, hind margin truncate; female, subtruncate or very slightly convex. Sixth segment, male, subtruncate; female, convex, narrower than that of the male.

Male genitalia.—Penis seen in profile, lower margin straight until near apex, then curved up; upper margin nearly straight for about half the length, then curved up and sharply bent back to the original direction so that the apical half is considerably wider than the basal half. Seen from below, a tube, about 0.2 mm. wide, split along its entire length and ending in two short, well-separated points. Near the apex the margin of the seam is bent vertically up. The two apical points are joined immediately to the apical margin of the orifice. Paramera slender, 0.7 mm. long, shorter than the penis, about 0.06 mm. wide, periphery of the apical fourth covered with rather short hairs. Sipho bent through 180° near base and continues nearly straight after that for most of its length. Near apex it is widened and a side branch emerges from it and extends about 0.3 mm. beyond the main part, then is curved inward and thickened at its apex. The orifice is terminal to the main part.

Female genitalia.—Of the *flavicollis* type, plates very narrow and dark toward apex.

Length.—4.0 mm.

Color and maculation.—Upper side brick red; pronotum with a transverse spot which has almost the complete width of the pronotum and is angular behind. Elytra each with five spots, the first elongate oval near the suture, but not touching it; No. 2 crescent-shaped, concave inward, on the outside very close to, but not quite touching, the margin around the humeral angle, partly encircling the callus, the hind tip touching spot No. 1; No. 3 transversely rectangular, No. 4 subquadratic with rounded corners; No. 5 rhomboidal. Pubescence light gray, black on the spots. Under side mostly black, except prosternum, parts of mesosternum, and the last abdominal segments, the latter two, however, are not completely light. Appendages and epipleurae light.

Type locality.—India.

Material examined.—2 specimens: India, near Darjeeling, eastern Himalayas, alt. 7,000-8,000 feet, May 1910 (R. B. Horsfall, AMNH).

Remarks.—This species agrees very well with Sicard's description except that the head and pronotum have the same color as the elytra and are not yellow as Sicard states. Such color differences occur frequently within one species. As the name indicates, this species resembles in its maculation *A. mystica* (Mulsant) and forms an intermediary between the regular 5-spotted species such as *flavicollis* and *mystica*. It can easily be distinguished from other 5-spotted species by the form of spot No. 2.

28. AFISSA MYSTICA (Mulsant)

FIGURES 100, 169

E[pilachna] mystica MULSANT, 1850, p. 841.

Abdomen.—Abdominal lines complete, reaching to within one-third of the hind margin of the first segment, regularly curved into semicircles. Fifth segment, male, hind margin subtruncate; female, mildly convex. Sixth segment, male, emarginate; female, subtruncate.

Male genitalia.—Penis seen in profile, bent gently upward near the middle and down again just before the tip, which is a sharp point; length 0.9 mm., gradually decreasing in thickness from base to apex. Seen from below, tube split open for basal two-thirds. The last third solid, narrower (0.07 mm. wide) and ending in a single sharp point. Paramera slender, 0.85 mm. long, subparallel, 0.07 mm. wide, rim of apical third with a row of hairs. Sipho bent 180° near base, less strongly in the opposite direction near apex. Orifice rounded, subterminal.

Female genitalia.—Like those of *dumerili*. Basal ends of plates ending in sharp points, apex folded longitudinally. Length 1.0 mm.

Length.—5.0 to 5.8 mm. Body very convex. Tips of elytra broadly margined with heavy punctures.

Color and maculation.—Upper side brownish red; pronotum with a triangular discal spot; elytra each with five spots but the pattern considerably modified. Spots 1 and 2 together form practically a complete circle, 3 laterally and 4 longitudinally widened, the latter usually also extending to the margin. No. 5 when fully developed touching No. 4 near the suture and extending as a narrow curved band practically to the margin. In lighter specimens practically absent or a narrow elongated spot near the suture. Pubescence light, dark on the spots. Under side and appendages light, metasternum and mesosternum and most of abdomen dark.

Type locality.—East Indies (?).

Material examined.—5 specimens: Himalaya (NM); India, Sikkim.

29. AFISSA DECEMGUTTATA (Weise)

FIGURES 98, 167

Solanophila decemguttata WEISE, 1923b, p. 183.

Abdomen.—Abdominal lines not quite complete, forming a regular arc reaching to within one-third of the hind margin of the first segment. Fifth segment, male, subtruncate. Sixth segment, with hind margin evenly convex.

Male genitalia.—Penis seen from below, a tube split open along the middle; the tube proper narrows gradually toward the apex and ends in a fine straight point. While the tube narrows, a side flange develops on each side so that the total width of the penis remains approximately constant (0.2 mm.). The apex is cut off squarely but the point into which the penis tube ends extends about 0.1 mm. beyond it. Paramera narrow, about 0.7 mm. long, less than 0.1 mm. wide, curved down in their basal third, from then on straight. In their apical half sparsely clothed with long blond hairs. Sipho long, only slightly tapered, about 0.07 mm. thick in middle, curved near the base, from then on straight, ending in a blunt point with the small orifice just before it.

Length.—4.7 mm. Elytra with very coarse punctures.

Color and maculation.—Upper side red, pronotum with a small black spot in the middle nearer the front margin than the base; elytra each with five spots, Nos. 1 and 3 close to the suture but not touching it, No. 4 touching the margin, Nos. 3 and 5 transversely broadened. Pubescence light gray, dark on the spots. Under side light, with the sides and the metasternum black and part of the abdomen dark.

Type locality.—Formosa, Taihorin.

Material examined.—Formosa, Musha, May 3, 1929 (K. Sato, NM).

30. AFISSA ANHWEIANA, new species

FIGURE 226

Abdomen.—Abdominal lines subcomplete reaching to within one-fourth of the hind margin of the first segment. Fifth segment, wide in both sexes, slightly emarginate in the male, convex in the female. Sixth segment, not protruding from under the fifth.

Male genitalia.—Penis 1.5 mm. long; seen from below, a tube 0.3 mm. wide, closed for about two-thirds of its length with the seams open, beyond this an open trough. Apex with two points 0.15 mm. apart, with a semicircular emargination between them. Seen from the side, mildly curved up near its apical third and gradually tapering

in thickness. Paramera 1.35 mm. long, greatest width 0.2 mm. near the apex. Rim of apical half with long (0.5 mm.) blond hairs. Sipho long and slender, curved 180° near base, a notch on the outside just before the tip carries the oval orifice. The sipho tube laterally compressed just before the notch.

Female genitalia.—Plates very elongate triangle, as in figure 207, but even more elongate. Length 1.2 mm., greatest width 0.27 mm., inner edge distinct and straight.

Length.—7.5 mm. Elytral epipleurae with traces of cavities for the reception of the hind femora. Mandibles with a broad single apical and one lateral tooth, no dentules (as in fig. 1 F, but less elongate).

Color and maculation.—Upper side light reddish brown with long whitish-gray pubescence. Pronotum with a median black spot of varying size and shape. It may be transverse about half the width of the pronotum, almost touching the front margin but leaving about a third free at the hind margin. It may be much smaller and diamond-shaped, situated in front of the middle. Elytra each with five rather large black spots. Nos. 1, 3, and 5 close to the suture but not touching it. No. 1 elongately oval, line tangent to the common base passing through the middle of the scutellum. No. 2 behind the callus. No. 3 big, transverse, inner edge straight, outer one semicircular. No. 4 elongately oval, not touching the margin. No. 5 variable in size and shape. In the darkest specimen the spot almost reaches from suture to margin, and there is a fine dark line parallel to the suture and close to it connecting spots 3 and 5. Under side and appendages light brown, except the tips of the mandibles, which are dark.

Type.—Museum of Comparative Zoology, from China, Anhwei Prov., Taipingshien, October 1932 (G. Liu).

Material examined.—1 paratype, same data as type, 1 specimen: Anhwei Prov., Kiuhua Shan, September 1932 (Liu, D).

31. AFISSA LONGISSIMA, new species

FIGURES 104, 173, 207

Abdomen.—Abdominal lines subcomplete, reaching to about within one-fifth of the apical margin, broadly rounded. Fifth segment, male, hind margin truncate to slightly concave; female, convex. Sixth segment, male, distinctly emarginate; female, convex.

Male genitalia.—Penis a flattened tube 1.8 mm. long; seen in profile, practically straight, the apical point turned up, diminishing in thickness from base to apex. Seen from below, tube split open along

whole length except for apical point, very flattened toward apex. Base of apical point beginning behind the elongate orifice, raised above the rest. Point long, with the sides almost parallel, less than 0.1 mm. wide at base, curving up. Paramera 1.2 mm. long, much shorter than penis, slender, subparallel with rounded apex, greatest width slightly more than 0.1 mm. Sides of apical third covered with a row of long (0.4 mm. max.) light blond hairs. Sipho very long (more than 5 mm.) and slender, width less than 0.05 mm. during most of its length, strongly curved through more than 180° near base, slightly in opposite direction near apex. Orifice terminal, small.

Female genitalia.—Plates very elongate, 1.03 mm. long, ending at base in sharp point. Emargination on inner margin near apex.

Length.—6.5 to 7.0 mm. Apical angles of elytra rounded.

Color and maculation.—Upper side light brownish red, pronotum with small central spot, elytra with five spots arranged as shown in figure 104. No. 3 very wide and touching or almost touching No. 4, which touches the margin. Pubescence light gray except on the spots. Under side and appendages light except the sides of the metasternum and the tip of the mandibles.

Material examined.—Type: U.S.N.M. No. 57146, Formosa, Taihoku, September 22, 1927 (T. R. Gardner).

1 paratype: Same data.

32. AFISSA CHINENSIS (Weise)

FIGURE 225

Solanophila chinensis WEISE, 1912, p. 112.

Abdomen.—Abdominal lines complete, rounded, reaching to within one-quarter of the hind margin. Fifth segment, male, hind margin truncate or slightly convex; female, convex. Sixth segment, convex in both sexes.

Male genitalia.—Penis seen in profile, 1.0 mm. long, lower edge straight for the basal two-thirds, then gently curved up and again curved up at the tip. Seen from below, straight tube, about 0.15 mm. wide, closed with a seam along the middle, orifice subterminal, oval. Paramera 0.9 mm. long, slender, maximum width (near apex) 0.07 mm., rim covered for apical two-thirds sparsely with row of blond hairs (about 0.25 mm. long). Sipho bent near base through an 180° arc, then straight and near apex bent outward again through nearly 180°, but arc smaller, distance between vortices of bends 1.8 mm.; orifice terminal.

Female genitalia.—Shape as in figure 210. Length of plates 1.0 mm., greatest width 0.3 mm.

Length.—5 to 5.5 mm. Mandibles with a tridented apical tooth and two large lateral teeth and one small one. The latter at the base of the innermost of the two larger teeth.

Color and maculation.—Upper side brownish red. In the darker specimens with a transverse black spot at the base of the head; pronotum with a transverse black spot which occupies about two-thirds the width and one-half the length of the pronotum and is closer to the front than to the hind margin. Elytra with five large black spots, No. 1 a common spot on the suture reaching or almost reaching the base and enveloping the scutellum, which remains light; No. 2 rounded and practically touching the margin; No. 3 transverse, not reaching the suture; No. 4 a little longer than wide, on the margin; No. 5 rounded, not reaching either suture or side margin. Pubescence light gray, dark on the elytral spots. Under side light, but sides of metasternum dark.

Type.—Hamburg Museum.

Type locality.—Fo-kien.

Material examined.—4 specimens: China, Anhwei Prov., Taipingshien, October 1932 (Liu, MCZ, D).

Remarks.—These specimens agree in all particulars with Weise's description. There are four additional specimens which show no noticeable differences in structure. They have the same general appearance except that the pronotal spot now covers practically the whole pronotum and leaves light only a narrow margin all around. Spot No. 1 does not touch the suture or base and is oval and longer than wide. The other spots show no difference. Unfortunately, all specimens are females, and so in the absence of the male genitalia absolute certainty cannot be obtained on whether this is more than just a color variation. The two forms are sharply differentiated without intermediates. These forms are tentatively regarded as a variety of *A. chinensis.*

AFISSA CHINENSIS var. SEPARATA, new variety

Like the ground form except that the pronotal spot leaves only a narrow light margin and elytral spot No. 1 does not touch suture or base and is longitudinally oval.

Material examined.—Type: Museum of Comparative Zoology, from China, Anhwei Prov., Taipingshien, October 1932 (Liu).

3 paratypes, all from China, Anhwei Prov., 1 same data as type, 2 from Kiubua Shan, September 1932 (Liu, MCZ, D).

33. AFISSA PROVISORIA, new species

FIGURES 103, 174

Abdomen.—Abdominal plates coming to within about two-fifths of the hind margin of the first segment. Fifth segment, male, moderately concave; female, truncate. Sixth segment, male, hind edge convex, with a distinct emargination in the middle, to truncate; female, convex.

Male genitalia.—Seen from below, two parallel almost cylindrical bars which unite at apex to form a sharp barely split point. The bars are connected on their upper side by an almost clear membrane. Seen in profile, gently curved up near base, from then on straight to apex. Paramera shorter than penis, about 0.5 mm. long, slender, greatest width about 0.1 mm., covered with hairs on inside of apical half. Sipho curved near base and very slightly in the opposite direction near apex.

Female genitalia.—As in *flavicollis.*

Length.—5.5 to 6.0 mm. Mandibles with one lateral tooth, no dentules; apical tooth trifid. Shape: side margins of elytra nearly straight, parallel.

Color and maculation.—Upper side brownish yellow, head with a transverse dark spot at the base almost reaching from eye to eye; pronotum with a big discal spot leaving only a very narrow margin in front and back and about a quarter of the width at each side. Elytra with five big dark spots as in figure 103. Spots 1 and 3 almost but not quite reaching the suture. Under side dark, but part of prosternum and apical segments of abdomen slightly lighter. Epipleurae of prothorax and elytra yellow, legs and mouth parts reddish; middle parts of femora usually darker.

Material examined.—Type: U.S.N.M. No. 57147, China, Szechwan Prov., Mount Omei, alt. 11,000 feet, August 19, 1934 (D. C. Graham).

5 paratypes, same data as type: Tsu Dien, Mount Omei, alt. 5,000-7,000 feet, August 7, 1925 (D. C. Graham, NM) (1 specimen); Mount Omei, August 6, 1938 (Dean Sage, Jr., MNH) (2 specimens).

Remarks.—This species agrees nearly with the description of several known species but exactly with that of none and is probably a hitherto undescribed species.

34. AFISSA OCELLATAE-MACULATA (Mader)

FIGURES 97, 165

Solanophila ocellatae-maculata MADER, 1930, p. 183.

Abdomen.—Abdominal lines variable, not quite complete, reaching to within less than one-fifth of the apical margin of first segment.

Fifth segment, male and female, hind margin subtruncate. Sixth segment, male, mildly emarginate; female, entire.

Male genitalia.—Penis seen from below, a tube split wide open lengthwise. Width 0.23 mm., seams apart 0.1 mm. The penis ends in a straight point. The upper wall of the tube is a semitransparent membrane. Paramera 0.7 mm. long, widened toward apex; greatest width 0.13 mm.; furnished on the rim of more than the apical half with blond hairs. Sipho short, widened near apex, orifice on one of the widened faces just before the tip, small and round.

Female genitalia.—Of the *flavicollis* type. Tergite X subtruncate.

Length.—4.8 to 5.4 mm.

Color and maculation.—Upper side light reddish brown; pronotum with a transverse black band almost but not quite from side to side. In the lightest specimens resolved into three separate spots, in the darkest continuous and leaving only a narrow light margin on base and apex, usually taking up about the middle third. Elytra with five dark spots arranged 2, 2, 1 as in *flavicollis;* Nos. 1 and 3-5 deviating only little from circular shape. No. 2 like an inverted comma, when fully developed touching No. 1. The space between the spots dark, but less so than the spots themselves, and a ring around each spot completely light. Pubescence light gray, black on the spots. Under side almost completely black in the darker specimens with large parts of abdomen and prosternum light in the lighter specimens. Mouth parts, legs, and epipleurae light. Femora with a dark spot in the darker specimens.

Type locality.—China, Yunnan Prov., mountains near Mengtze.

Material examined.—19 specimens (D. C. Graham), all from China, Szechwan Prov., from the following localities: Wei Chow, 65 miles northwest of Chengtu, alt. 9,000-12,500 feet, August 12, 1918; alt. 5,600-8,900 feet, July 26-30, 1933; near O Er, alt. 6,000-15,000 feet, August 6-18, 1933; Beh Luh Din, 30 miles north of Chengtu, alt. 6,000 feet, August-September 1943; Hua Yin Shan, 70 miles north of Chungking, alt. 2,500 feet, July 5, 1933; near Fu Liu, alt. 3,000-8,000 feet, August 18-21, 1926; alt. 5,000-8,200 feet, July 19-21, 1928; near Kuanhsien, alt. 2,000-4,000 feet, August 1933; Ningyuenfu, alt. 7,800 feet, August 13, 1928.

35. AFISSA PLICATA (Weise)

FIGURE 97A

Epilachna plicata WEISE, 1889, p. 649.

Abdomen.—Abdominal lines nearly complete, curved in regular arc. Fifth segment male, hind margin truncate; female, slightly convex. Sixth segment, male, mildly emarginate; female, entire.

Male genitalia (see fig. 165).—Penis seen from below, a tube cut in half lengthwise, ending in a straight point, width 0.23 mm. The upper wall of the tube is a semitransparent membrane. Paramera 0.7 mm. long, widened slightly toward apex, greatest width 0.11 mm., furnished on the rim of more than apical half with blond hairs. Sipho short, widened near apex, orifice small, round, on one of the widened faces just before the tip. Genitalia indistinguishable from those of *ocellatae-maculata*.

Female genitalia.—Of the *flavicollis* type, like *ocellatae-maculata* (Mader).

Length.—5.0 to 6.0 mm. Elytra near apex with a plica parallel to the side margin.

Color and maculation.—Upper side yellowish brown; pronotum with a transverse dark band, which in the lighter specimens seems to resolve into six or seven indistinct spots; in the darker specimens a big central spot to which a lateral spot is joined at each side. Elytra with three transverse bands, which can be recognized as a modification of the 5-spotted pattern of the *flavicollis* type. Spots 1 and 2 are joined together and form a distorted semicircle open in front. Spot 3 is widened laterally, while spot 4 remains nearly circular. In many specimens these two spots are joined together to form a continuous narrow band, reaching from margin to suture but not quite touching either. Spot 5 also widened laterally into a band, which reaches nearly from margin to suture. Under side dark, except the prosternum, most of the middle of the basal segments and the entire apical segments, and often the middle of mesosternum light; mouth parts, legs, and epipleurae light.

Type locality.—China, Kansu Prov.

Material examined.—13 specimens (D. C. Graham, NM), all from China, Szechwan Prov.: Near Mupin, alt. 3,000-7,400 feet, alt. 3,000-7,600 feet, July 1-3, 1929; alt. 7,000-13,000 feet, July 6-8, 1929; alt. 5,000-6,500 feet, July 22-24, 1929; Mupin, alt. 4,500 feet, July 24, 1929; alt. 5,000-6,000 feet, July 3, 1929.

Remarks.—The very great similarity of the structure of both male and female genitalia shows that *A. plicata* (Weise) and *A. ocellatae-*

maculata (Mader) are very closely related. The presence of the plica in *A. plicata* and the difference in maculation render it, however, very easy to keep the two species apart.

Only a single female is available of each of the following six species, a situation that makes it difficult to establish their affinity. The structure of the female genitalia and, except for *lugubris,* the spot pattern leave no doubt that they belong to the *flavicollis* group. They are also sufficiently different in structure from each other and other species to make it relatively certain that they belong to distinct species.

36. AFISSA ANNAMENSIS, new species

FIGURE 102

Abdomen.—Abdominal lines subcomplete, rounded, reaching to within about one-fourth of the the hind margin of the first segment. Fifth segment, female, hind margin truncate. Sixth segment, entire.

Female genitalia.—Of the *flavicollis* type.

Length.—8.5 mm.

Color and maculation.—Upper side red. Pronotum with a small, not very distinct, dark discal spot. Elytra each with five black spots: Nos. 1 and 2 almost touching the base and joined together; No. 3 subquadratic, near the suture; No. 4 almost touching the margin; No. 5 transverse, slightly emarginate behind, a little closer to the margin than to the suture. Pubescence light gray, dark on the spots. Under side and appendages light, except metasternum, the middle part of the first three abdominal segments, and the tips of the mandibles, which are dark.

Type.—U.S.N.M. No. 57148, Indochina, Annam Prov., Haut Donai, Col de Blao, alt. 900 meters, September 30, 1932 (M. Poilane).

37. AFISSA INDOSINENSIS, new species

Abdomen.—Abdominal lines complete, wide, reaching to within one-fourth of the hind margin of the first segment. Fifth segment, female, wide, hind margin convex. Sixth segment, convex.

Female genitalia.—Of the *flavicollis* type; length of plates 0.95 mm.; greatest width 0.25 mm.

Length.—6.0 mm.

Color and maculation.—Upper side dark brownish red; pronotum with two large transverse spots narrowly interrupted in the middle. Elytra each with five black spots: No. 1 on the suture, reaching almost

to the base but leaving the scutellum light; No. 2 rounded, on the callus; No. 3 slightly transverse; No. 4 touching the margin; No. 5 subapical, rounded closer to the suture than to the margin. None of the spots, because of the relatively dark ground color and their somewhat hazy outlines, are very distinct. Pubescence long, white, brown on the spots. Under side light brown, sides of metasternum and basal part of abdomen darker.

Type.—U.S.N.M. No. 57149, Indochina, Annam Prov., Haut Donai, Agr. Station of Blao, alt. 800 meters, April 10, 1933 (M. Poilane).

38. AFISSA ORTHOFASCIATA, new species

FIGURE 101

Abdomen.—Abdominal lines complete, broadly rounded, reaching to within one-third of hind margin of first segment. Fifth segment, female, hind margin convex. Sixth segment, narrow, hind margin convex.

Female genitalia.—As in *flavicollis,* plates somewhat wider, 1.05 mm. long.

Length.—6.5 mm.

Color and maculation.—Upper side red, pronotum spotless, elytra with two straight transverse black fasciae, the first along the base, leaving only the scutellum red, hind margin nearly straight; the second about the middle of the elytra narrower and slightly compressed in the middle of each elytron. In addition a subapical black spot, touching the margin but removed from the suture. Pubescence light red, black on the spots. Under side light, prosternum, metasternum, and the middle of the first three abdominal segments black; appendages light, tip of mandibles dark.

Type.—U.S.N.M. No. 57150, Java, Tjibodas, Mount Gede, April 20, 1909 (Bryant and Palmer).

Remarks.—This species resembles superficially very closely *Epilachna parafasciata* from the same locality. The two can easily be told apart by the generic characters (structure of claws, sixth abdominal segment, and female genitalia). There are other minor differences, but the similarity of the color pattern is striking. *E. parafasciata* is somewhat more yellowish.

39. AFISSA COMPLETA, new species

FIGURE 108

Abdomen.—Abdominal lines complete, evenly rounded and reaching to within about one-fourth from the hind margin of the first segment.

Fifth segment, female, with moderately convex hind margin. Sixth segment, narrow, strongly convex hind margin.

Female genitalia.—Of the *flavicollis* type.

Length.—8.0 mm.

Color and maculation.—Light reddish brown; pronotum with a big transverse discal spot that leaves only the margins free. Elytra with four big spots that leave only narrow margins of light color at the suture and between the spots. The first, which is apparently spots Nos. 1 and 2 of the 5-spotted pattern united, has an emargination at the callus. Surface shining with sparse pubescence (possibly partly rubbed off in the specimen). Under side dark on sides of metasternum and the basal part of abdomen, the rest light.

Type.—U.S.N.M. No. 57151, China, Szechwan Prov., Lu Ding Chiao, 5,000 feet, July 13, 1930 (D. C. Graham).

Remarks.—This species, which, because of the structure of the abdomen and genitalia, must be placed in the *flavicollis* group and not near *convexa* which it resembles superficially, seems to be very close to *Solanophila lenta* Weise (1902, p. 495; type locality, Tonkin). The chief difference seems to be the size and the fact that *lenta* is subopaque, but *completa* shiny.

40. AFISSA INTERMIXTA, new species

Abdomen.—Abdominal lines complete, reaching to within about one-third of hind margin of first segment. Fifth segment, female, hind margin convex. Sixth segment, convex, very short.

Female genitalia.—Of the *flavicollis* type, as in figure 206.

Length.—4.8 mm.

Color and maculation.—Upper side light yellowish brown. Pronotum with three dark spots, each about one-sixth of the width of the pronotum. The central one a little before the middle, darker than the lateral ones, which are close to the margin. Elytra each with seven dark spots. This can be regarded as the normal 5-spotted regular pattern of the *flavicollis* group with the following modifications: Spot No. 2, which is crescent-shaped in several species, is completely split in two with the callus between the parts; No. 3 very large, laterally widened; No. 4 circular, not touching the margin; No. 5 about where it is normally in this group. In addition another spot near the margin very slightly farther back. Pubescence light yellowish, dark on the spots. Under side and appendages light to darkish brown.

Type.—U.S.N.M. No. 57152, India, Assam, Dibrugarh, March 20, 1944 (D. E. Hardy).

Remarks.—The shape of the female genitalia leaves little doubt that this species belongs to the *flavicollis* group, although it is the only species of this group known so far having more than five spots.

41. AFISSA LUGUBRIS, new species

FIGURE 106A

Abdomen.—Abdominal lines complete, reaching to within one-fourth of the hind margin of the first abdominal segment and evenly curved. Fifth segment, female, hind margin convex. Sixth segment, hind margin convex, scarcely protruding from under the fifth.

Female genitalia.—Almost exactly like those of *flavicollis* (fig. 206). The only noticeable difference is that the inner margins of the plates are more distinct near their base and overlap.

Length.—6.0 mm. Mandibles with a strongly bifid apical tooth and two lateral teeth of almost equal size without dentules.

Color and maculation.—Upper side black; head partly lighter, pronotum with an indistinct lighter margin. Elytra each with six reddish-brown spots with indistinct outlines arranged 1, 2, 2, 1, the first touching the base. Under side dark with prothorax and mesothorax, epipleurae, abdomen toward apex, and appendages more or less lighter.

Type.—U.S.N.M. No. 57153, China, Kiautschau.

Remarks.—This species agrees reasonably well with the description of *Epilachna pembertoni* Crotch (1874, p. 80; type, Indian Museum; type locality, India, Bhootan). The identity of *lugubris* with *pembertoni* Crotch seems, however, doubtful because of some differences in coloration and the difference in locality.

IV. COMPLICATA GROUP

This group is best characterized by the structure of the abdomen and the genitalia. The last visible abdominal segments are greatly modified in most species of this group, particularly in the males, and such modifications have not been observed in any other group of *Afissa*. These modifications consist of deep emarginations, depressions, greater degree of sculpture in general, and processes on some segments, and may affect the third to sixth visible segments. The greatest degree of modification is observed in *Afissa complicata*.

The female genitalia have tergite X with a simple convex to slightly emarginate apical edge, which distinguishes this group sharply from the *szechuana* and *chapini* group where the edge is bent double. The plates are suboval, wider than in the *flavicollis* group and with the

greatest width in the apical half. The male genitalia (figs. 175, 176, 179) are rather elaborate in *convexa* and *complicata* and in all cases have very wide paramera, wider than in any other *Afissa* group. The sipho is relatively straight and short.

The basic spot pattern in this group, as in the preceding and following one, consists of five rather large spots on each elytron which may flow together and cause the upper side to be predominantly black in some species.

The group consists of four moderately large (6 to 9 mm. long) species from China, three of them new.

42. AFISSA CONVEXA, new species

FIGURES 109, 175, 213

Abdomen.—Abdominal lines terminal, incomplete. The outer margin curved inward and reaching to about the middle of the first segment. Punctation of central part of first segment normal, not consisting of wide circular punctures (as in *admirabilis* or *chapini*). Fifth segment, male, in the middle very convex with a depression on each side, hind margin approximately straight; female, uniformly bent and only slightly convex, hind margin with a broad, shallow emargination. Sixth segment, male, strongly convex with the hind margin deeply emarginate; female, bilobed with a deep notch between the lobes, but not completely split. Seventh segment appearing through the emargination.

Male genitalia.—Penis about 2.2 mm. long, a high narrow tube, split lengthwise in the middle on the under side. The apex open, with the upper part reaching farther back, bilobed and ending in two blunt points curved mildly upward. Penis sparsely covered with hairs on its upper middle. Paramera spoon-shaped, about 1.7 mm. long, maximum width 0.5 mm. On the apical part the edge covered densely with long (0.5 mm.) blond hairs. These are much longer and denser on the upper edge than on the lower one. Sipho slightly S-shaped, almost straight, bent sharply just before the apex and ending in a sharp point. Orifice just inside this bend, elongate.

Female genitalia.—Tergite X, subtruncate with a slight emargination, sides slightly convex, at the base the pigment limited by an almost semicircular line. Plates 0.75 mm. long, oval, pointed at base, inner edge nearly straight.

Length.—7.5 to 8.5 mm. Side of elytra compressed just before apex, so that the reflexed margin appears wider there.

Color and maculation.—Upper side, color light yellowish brown.

Pronotum with a big central spot touching the base and reaching almost or entirely to apex and a smaller spot on each side. Elytra with five large black spots, Nos. 1 and 2 often touching, No. 4 touching the margin. Pubescence blond, dark on the spots. Under side same color as above with metasternum black and the abdomen more or less dark brown to black. In light specimens the last segments are completely light, and the middle of the second to fourth; in dark specimens only the sixth and the middle of the fifth. In such specimens also the mesosterna, prosterna, and femora are darker. Otherwise appendages light except tips of the mandibles.

Material examined.—Type: U.S.N.M. No. 57154, from China, Szechwan Prov., near Mupin, alt. 3,000-7,600 feet, July 1-3, 1929 (D. C. Graham).

7 paratypes, 6 from same locality: alt. 7,000-9,000 feet, July 17, 1929; alt. 7,000 feet, July 18, 1929; 7,000-13,000 feet, July 6-8, 1929.

Additional specimens: between Chengtu and Kuanhsien, July 2-5, 1924.

Remarks.—This species is in appearance very similar to *A. sustenans, complicata,* and *subacuta.* It can easily be distinguished from them by the structure of the abdomen and the genitalia. The differences in maculation are distinct though slight, but it is not sure whether they would hold in a large series.

43. AFISSA COMPLICATA, new species

FIGURES 111, 176, 214

Abdomen.—Abdominal lines subterminal, incomplete, the apical part flattened and parallel to the apical edge of the segment, the outer part parallel to the margin of the segment and ending in a small depression not far from the middle of the segment. *Male:* Third and especially fourth segment much narrower in the middle than at the sides, the fourth with a process beginning at the middle of the apical margin and reaching back over the fifth segment. It is about 0.4 mm. long, ends in a fork, and serves to support the extended genitalia. The fifth segment also shows considerable modifications. It has a wide semicircular groove reaching from side to side with elevated edges bordering it, especially the basal edge near the sides. At the middle of its apical margin it bears an erect emarginate process shorter than the one of the fourth segment. The sixth segment is deeply emarginate, practically to its base, and through this opening the seventh segment emerges. *Female:* Third and fourth segments are normal, that is, of equal uniform width and with truncate hind margins. The fifth

segment is strongly emarginate. There is a basal depression in the middle and an apical one on each side of it, but apparently this segment is not very strongly sclerotized and these depressions are smoothed out in some specimens. Sixth segment mildly bilobed, also weakly sclerotized.

Male genitalia.—These are equally as elaborate as the abdominal segments. Figure 176 shows the genitalia of *sustenans,* which have practically the same structure as those of *complicata.* The penis tube, straight, 1.0 mm. long, split open on its under side, is under a wide shield and partly fused to it. The shield has parallel smooth edges and ends in a point, which is sharply bent down. On the basal two-thirds of its upper side it carries a sharp median vertical ridge with a few hairs on each side. Paramera spoon-shaped, about 1.0 mm. long, 0.5 mm. in maximum width, with long hairs (about 0.4 mm.) around most of the margin. Sipho very slightly bent near base, the apex as in figure 176.

Female genitalia.—Tergite X with the apical margin regularly convex. Plates elongately oval, pointed at base with the inner margin emarginate.

Length.—7.2 to 9.0 mm.

Color and maculation.—Upper side light yellowish brown; pronotum with a median spot closer to base than apex, which shows signs of being due to the confluence of two longitudinal spots close to the middle. In some specimens there are indications of a lateral spot. Elytra each with five large black spots: Nos. 1 and 2 subtriangular, No. 4 touching the margin. Pubescence light blond, black on the spots. Under side and appendages mostly light on the lighter specimens. Most of metasternum, basal parts of abdomen, and tips of mandibles dark. In the darker specimens the dark coloration may spread over most of the abdomen, the mesosternum, and part of the prosternum. Also the femora are darker in such specimens.

Material examined.—Type: U.S.N.M. No. 57155, from China, Szechwan Prov., near Mupin, July 1-3, 1929, alt. 3,000-7,400 feet, (D. C. Graham).

10 paratypes, all China, Szechwan Prov. (Graham, NM): Same data as type (4 specimens); between Yachow and Tatsienlu, alt. 2,200- 8,000 feet, July 7-14, 1930; near Washan, alt. 2,000-5,000 feet, July 18, 1925; Mount Omei, Si Gi Pin, alt. 4,000-6,000 feet, August 6-15, 1925.

Remarks.—Afissa complicata can easily be distinguished from other species with similar appearance by the remarkable structure of the abdomen. It also is well characterized by the genitalia.

AFISSA COMPLICATA var. SUSTENANS, new variety

FIGURES 110, 176

This form is so close to *A. complicata* that although there are a few distinct differences it is probably only a variety. More material would settle this definitely. The differences from the typical *complicata* are as follows: In external appearance *sustenans* seems to be a form with the black pigment more developed than in *complicata* s. str. The pronotum is black with a narrow light margin, but there are intermediates between this and the typical *complicata* form (fig. 111). The elytral spots are larger, Nos. 1 and 2 touch (in one specimen both in front and back so that they enclose a small oval light space), Nos. 3 and 4 are joined together, and No. 5 practically extends from suture to margin.

The genitalia show some slight differences. The shield of the penis has parallel edges in *complicata,* but they diverge and are more ragged in *sustenans,* though the raggedness is somewhat exaggerated in figure 176. The tip of the sipho has the apical process shorter and less distinct and less strongly bent back.

Material examined.—Type: U.S.N.M. No. 57156, China, Szechwan Prov., near Yueh Shi, alt. 4,000-8,000 feet, July 21, 1928 (D. C. Graham).

2 paratypes, both Szechwan Prov. (Graham, NM): Between Yachow and Tatsienlu, 3,000-8,000 feet, July 10-13, 1920; near Tatsienlu, 5,000-8,500 feet, August 7, 1923.

44. AFISSA HAUSERI (Mader)

FIGURES 112, 179

Solanophila Hauseri MADER, 1930, p. 182.

Abdomen.—Abdominal lines subterminal, incomplete, the outer margin parallel to the margin of the segment, at about one-third from the base a sharp depression, which may give the impression that the outer margin curves inward. *Male:* Hind margin of fourth segment broadly V-shaped; fifth segment deeply emarginate with a strong depression in the middle, sixth segment also deeply emarginate with a process ending in a fork at the middle of apex. *Female:* Fourth segment in middle with only a very slight broad notch, fifth segment hind margin mildly emarginate, with a semicircular depression less marked than in the male, sixth segment also with hind edge emarginate but without trace of a depression.

Male genitalia.—Penis seen from below, first half open tube with

approximately parallel side margins, after that widening and flattened out and ending in two widely divergent points; upper side of penis flattened, the flat part widest at apex and narrowing to a sharp point at base; no hairs. Paramera 1.2 mm. long, spoon-shaped, greatest width about 0.4 mm., the apical half dark brown, almost black in some specimens, with long light blond pubescence (about 0.5 mm. long). Sipho short.

Female genitalia.—Plates pointed at base, 0.85 mm. long, greatest width 0.35 mm. a little beyond the middle. Tergite X with apical edge gently convex with a trace of an emargination in the middle.

Length.—7.0 to 8.2 mm.

Color and maculation.—Head light brown, pronotum dark except the front margin and the front angles, to different extent in different specimens. Elytra black with red spots, the first longitudinal halfway between scutellum and callus touching the base; then follows an irregular fascia narrowly interruped at the suture and not reaching the sides; in the darkest specimen there is indication that it has resulted from the confluence of two spots. At about three-fifths a similar fascia which in the darkest specimen actually is resolved into two spots on each elytron. Finally there is a red spot at the apex. Pubescence distinct and long, light gray on the black, reddish on the red parts. Under side light brown, darker on metasternum and most of abdomen. Legs light, dark brown in one specimen.

Type locality.—China, Yunnan Prov., mountains near Mengtze; Kiautschau.

Material examined.—5 specimens: China, Szechwan Prov., between Yachow and Mupin, alt. 5,000-10,000 feet, September 1930; near Mupin, alt. 6,000-7,000 feet, July 17, 1929; Mupin, alt. 3,500-5,000 feet, July 1, 1929; Mount Omei, alt. 4,000-6,000 feet, August 19, 1934 (D. C. Graham, NM); Shantung Prov., Kiautschau.

Remarks.—Mader's description of *hauseri* unfortunately is based entirely on color and omits the structure of the abdominal segments, which would have permitted a much more positive identification. None of the five specimens fits Mader's description exactly, as it was based on darker specimens that showed five light spots on a dark background. However, the coloration of the pubescence, different from that of all other species, leaves little doubt about the identity with *hauseri* (Mader).

45. AFISSA DOBZHANSKYI, new species

Abdomen.—Abdominal lines terminal, incomplete, the outer edge parallel to the margin of the first abdominal segment. Fifth segment, female, hind margin convex. Sixth segment, truncate.

Female genitalia.—Very similar to those of *A. hauseri;* tergite X with apical margin truncate or slightly convex; plates elongate with pointed base, 0.80 mm. long, greatest width 0.27 mm.; inner edge without pigment and straight. The chief difference with the genitalia of *hauseri* seems to be the slightly slenderer shape and the smaller amount of pigment of the plates.

Length.—6.0 mm. Epipleurae with a distinct cavity for the reception of the tips of the hind femora.

Color and maculation.—Upper side brownish red; pronotum with the disk dark so that only a relatively narrow light margin remains on all sides. Elytra with a large common scutellar spot, each with an elongate humeral spot. In addition with two dark fasciae, the discal one due to the confluence of spots 3 and 4, somewhat bent back at the suture and narrowly connected with the scutellar spot. The subapical fascia due to the widening of the usual subapical spot. Pubescence light gray on the dark spots, rubbed off almost everywhere else on the unique specimen. Under side light to dark brown, metasternum black.

Type.—U.S.N.M. No. 57157, China, Kiautschau, a specimen obtained from Prof. Th. Dobzhansky.

Remarks.—This species is very close to *Afissa hauseri.* It differs by the structure of the abdomen and the presence of distinct epipleural cavities, which are only slight depressions in *hauseri.* The elytral pattern also shows differences, and the size is smaller. The evaluation of both of these differences is not safe from a single specimen.

V. SZECHUANA GROUP

The species of this and the *chapini* group are characterized by the fact that tergite X of the female has its apical part folded down and over so that the true apical margin points frontward. It is separated from the *chapini* group by the fact that the epipleurae do not have any cavities for the reception of the femora.

It consists of two species from China of moderate size (length 6 to 7 mm.), both of them new. The elytra have each five spots, as in all the groups III to VI. The male genitalia are of relatively simple structure and resemble those of the *chapini* group.

46. AFISSA SZECHUANA, new species

FIGURES 113, 177, 215

Abdomen.—Abdominal lines subterminal, incomplete. The outer part ending near the middle of the width of the first segment, parallel to the margin, and apex flat or very broadly rounded. Fifth segment, subtruncate in both sexes, with a narrow transverse depression in middle near hind margin in male. Sixth segment, male, with a deep emargination; female, subtruncate with a very shallow emargination.

Male genitalia.—Penis seen from below, tube about 0.23 mm. wide with nearly parallel sides until it narrows to apical point. A raised seam along practically the whole length, which terminates only when the penis narrows to point. Near the apex the walls of the seam diverge slightly to form the small elongate orifice. Seen in profile, gently curved down to the point, which is slightly bent up. Seen from above, nearly flat. Paramera gently curved down, 1.7 mm. long, slender, gradually narrowing toward apex, width in middle slightly less than 0.2 mm., apex covered with light blond hairs. Sipho almost bent into a semicircle. Orifice subapical on the inside.

Female genitalia.—The feature that distinguishes this and related species from the others of the same genus is the structure of tergite X. The apex of this segment is heavily sclerotized and has a deep V-formed emargination. Along this line it is folded downward and over. The true apex of the segment is therefore pointing frontward and is convex toward the front. Plates broadly oval, length 0.65 mm., greatest width 0.47 mm.

Length.—6.5 to 7.0 mm.

Color and maculation.—Upper side reddish, head with a half circular spot between the eyes, pronotum with a central and a smaller lateral spot. Elytra with five spots, No. 3 constricted in the middle as if it were due to the confluence of two spots. Under side black, side pieces of prothorax and mesothorax light, mouth parts and legs light, including coxae; femora, however, dark, except tips. Epipleurae dark except a narrow seam on the outer margin.

Material examined.—Type: U.S.N.M. No. 57158, from China, Szechwan Prov., near Mupin, alt. 3,500-5,000 feet, July 1-2, 1929; (D. C. Graham).

7 paratypes, from the same locality (D. C. Graham, NM): alt. 5,000-6,500 feet, July 22, 1929; alt. 5,000-6,000 feet, July 19, 1924, July 22, 1929.

47. AFISSA SUBACUTA, new species

FIGURES 105A, 216

Abdomen.—Abdominal lines subterminal, incomplete; the outer part ending near the middle of the width of the first segment, parallel to the margin; apex flat or very broadly rounded. Fifth segment with hind margin convex in both sexes. Sixth segment hardly protruding from under the fifth, little sclerotized, with a deep notch in the middle in the male, which practically bisects it entirely, with entire edge in the female.

Male genitalia.—Penis seen from below as gradually widening tube (0.30 mm. wide near apex) until it suddenly narrows into a fine slender point; tube with a longitudinal raised seam, orifice rounded; seen from above, with a pronounced ridge on basal half, in profile 0.4 mm. thick near base. Paramera gently curved down, length 1.5 mm., slender, width about 0.2 mm. at apex, with blond hairs. Sipho curved nearly into semicircle, tip compressed, orifice elongate on outside before compression. Very similar to those of *szechuana* but slightly wider, the orifice more rounded and the apical point slenderer.

Female genitalia.—Similar to *szechuana* and *chapini* in the fact that apex of tergite X is strongly sclerotized and folded down and back. The folding line, the apparent apex of the segment, however, is truncate and thin. Plates, length 0.52 mm., greatest width 0.44 mm.

Length.—6 to 6.5 mm.

Color and maculation.—Upper side reddish, head spotless, pronotum with a big central spot touching the base but not quite the front margin, and two smaller subcircular lateral spots on each side. Elytra with five large spots, No. 3 apparently arising from two confluent spots. In two of the three specimens this spot is joined to No. 4, which touches the margin, so that a continuous median fascia results which is narrowly interrupted at the suture. Spot 5 large, diamond-shaped, reaching almost from suture to side margin. Under side mostly black, side pieces of prosternum and mesosternum and part of abdomen light, mouth parts and legs light, except middle parts of femora, which are slightly darker, basal half of epipleura black in middle.

Material examined.—Type: U.S.N.M. No. 57159, from China, Szechwan Prov., Shin Kai Si, Mount Omei, alt. 4,500 feet, August 4-6, 1929 (D. C. Graham).

2 paratypes: Near Yachow, July 1929; between Kiating and Mount Omei, alt. 1,300-4,500 feet, August 21-22, 1925 (Graham, NM).

Remarks.—This species is very similar in appearance to *A. szechuana* and is closely related to it, although it can be easily separated from it by both differences in the maculation and the structure of the genitalia, especially the female genitalia. It agrees in most details with the description of *acuta* Weise, syn. *acuminata* Weise (1889, p. 648). But there is considerable deviation in the exact form of the elytral spots. Besides, *acuta* is reported to have a deep median notch in the fifth segment which reaches almost to its base. *A. subacuta* has such a notch in the sixth segment of the male. My experience with the species in this group makes it appear very doubtful whether Korschefsky (1933b, p. 300) was justified in attributing to *acuta* Weise two specimens from Formosa with different maculation of the same type.

VI. CHAPINI GROUP

This group consists of the three species *chapini, magna,* and *militaris,* whose close relationship is indicated by the similarity of their male genitalia (where known) and the fact that they have distinct cavities on the elytral epipleurae for the reception of the tips of the middle and hind femora. By this feature they are separated from the *szechuana* group, to which they are otherwise closely related.

The female genitalia are very similar to those of the *szechuana* group with the bent-over apical part of tergite X.

Among the Palaearctic and Indomalayan Epilachninae, distinct elytral cavities are otherwise found only in *Cynegetis,* and the presence of these cavities is usually considered a generic character. However, the *chapini* group is so close to the *szechuana* group that it certainly must be considered as belonging to *Afissa.* Traces of elytral grooves occur in other species. The only differences between *Cynegetis* and *Afissa* are: *Cynegetis* has the tarsal claws single with a tooth, whereas those of *Afissa* are double with both parts nearly the same size, and *Cynegetis* has the front tibiae grooved.

48. AFISSA CHAPINI, new species

FIGURES 115, 178, 217

Abdomen.—Abdominal lines terminal but incomplete, the outer margin not reaching beyond one-third from the hind margin of the first segment and coming close to the side margin. Fifth segment, male and female, hind margin evenly convex. Sixth segment, not protruding, with deep emargination in male, with a slight emargination in female.

Male genitalia.—Penis seen in profile, first gently bent down, shortly before apex suddenly bent up, becoming gradually thinner from base to apex; no hairs. Seen from below, as in figure 178. The middle opening closed on upper side with a clear membrane. Paramera slender, curved up, length 1.6 mm., greatest width 0.2 mm., on apical third with long (about 0.4 mm.) light blond hairs. Sipho short, curved nearly in semicircle.

Female genitalia.—Plates, length 0.49 mm., greatest width 0.55 mm., apical edge almost straight. Tergite X large, apex folded double, downward for about 0.3 mm.; both the apparent apex (the folding line) and the real one with a weak emargination.

Mandibles with one lateral tooth, no dentules. Epipleurae with deep cavitites for the reception of the tips of the hind and middle femora.

Length.—7 to 7.5 mm. Shape strongly hemispherical.

Color and maculation.—Upper side light red, pronotum spotless, elytra with five black rounded spots, No. 4 touching margin, 5 about halfway between suture and margin at about one-eighth distance from apex. Pubescence light blond, black on spots. Under side light brown, parts of metasternum and abdomen somewhat darker.

Material examined.—Type: U.S.N.M. No. 57160, from Philippine Islands, Luzón, Mount Maquíling (Baker).

3 paratypes (Baker, NM, D); Luzón, Mount Maquíling (2 specimens); Mindanao, Surigao (1 specimen).

Remarks.—This species, though in maculation resembling the *flavicollis* group, stands out from all other species except *magna* by the presence of the epipleural cavities. It is also remarkable by the structure of the abdomen and its genitalia, particularly the female ones.

49. AFISSA MAGNA, new species

FIGURES 114, 180

Abdomen.—Abdominal lines incomplete, subterminal; the outer part reaching to about the middle of the segment and coming to within less than 0.15 mm. of its side margin. Punctation in the middle of the segment with circular points of about 0.07 mm. diameter near base. Fourth segment, male, subtruncate. Fifth segment with convex hind margin. Sixth segment with a deep notch, not protruding from under the fifth.

Male genitalia.—Penis a flattened tube, split open on the under side, length 2.4 mm., gently curved down and suddenly bent up at apex

and ending in a single point. Upper wall a clear membrane. Paramera 2.1 mm. long, gently curved down, slender, greatest width near apex 0.2 mm.; apical third with long (0.4 mm.) blond hairs. Sipho bent slightly, suddenly becoming narrower before apex and flaring out.

Length.—8.8 mm. Epipleurae with cavities for the reception of the tips of the middle and hind femora, somewhat shallower than those of *chapini*. Metasternum very coarsely punctated.

Color and maculation.—Upper side brownish red. Pronotum with four rather indistinct dark spots. Elytra each with five large dark spots. Pubescence light gray, dark on the spots. Under side and appendages light brown, sides of metasternum, epipleurae of prothorax, and tips of mandibles darker.

Type.—U.S.N.M. No. 57161, China, Fukien Prov., near Foochow, 1921-1924 (C. R. Kellogg).

Remarks.—This species is very similar to *chapini* in all morphological details. However, the size, maculation, and structure of the genitalia easily distinguish the two species. *A. magna* also shows some similarities to *szechuana* but is easily separated by the presence of the epipleural cavities.

50. AFISSA MILITARIS, new species

Abdomen.—Abdominal lines incomplete, terminal, the outer edge parallel to the margin and close to it. Fifth segment, female, hind margin sharply convex. Sixth segment, convex, not protruding from under fifth.

Female genitalia.—Very similar to those of *A. chapini* (see fig. 217). The shape of the plates almost exactly the same, length 0.50 mm., greatest width 0.51 mm. Tergite X broad, the apex folded double as in *chapini*. The apparent apex has a slight emargination on each side of the middle. The part beyond the bend longer than in *chapini* and becoming more narrow. Length from bend to real apex, 0.46 mm., width at apex 0.16 mm., apex with a distinct emargination.

Length.—8.0 mm. Epipleurae with distinct cavities for the reception of the tips of the middle and hind femora. These are not quite so deep as those of *chapini*.

Color and maculation.—Upper side deep red; pronotum with an almost circular dark spot, which reaches from the base to about one-fifth of the apical margin. Elytra with two basal dark spots, one medial fascia and a subapical spot. The first spot elongate on the suture almost reaching the base; scutellum light. The second spot on the callus leaves a very narrow margin light on the side and

base. The fascia is not unlike that of figure 105A but is extended to the suture. The subapical spot is rhomboidal, touching the margin and practically reaching the suture but leaving the apex light. Pubescence light reddish on the red parts of the elytra, light gray on the black parts. Under side light to dark brown.

Type.—U.S.N.M. No. 57162, India, Assam, Dibrugarh, August 1943 (W. L. Jellison).

EPIVERTA, new genus

Genotype: *Solanophila chelonia* MADER.

Solanophila chelonia of Mader is so different from *Afissa* that it is properly regarded as the type of a new genus, of which it is the only known species.

The chief differences from *Afissa* are the following: The elytra are very broadly margined along their whole outer margin. The epipleurae are wide and vertical, whereas they are much narrower and subhorizontal in *Afissa*. The structure of the spot pattern is also quite different from any found in *Afissa,* and the mandibles show peculiarities not found anywhere else. The genitalia of the female also are different from those of any oriental *Afissa*. Those of the male are as yet unknown. *Epiverta* shows no traces of abdominal lines on the first segment.

EPIVERTA CHELONIA (Mader)

FIGURES 116, 218

Solanophila chelonia MADER, 1933, p. 79.

Abdomen.—With no trace of abdominal lines. Fifth segment, female, broadly emarginate; sixth segment, convex. Male unknown.

Female genitalia.—Tergite X with broadly convex hind margin, plates with slightly convex inner margins, overlapping somewhat, length 0.63 mm., greatest half-width 0.33 mm. Greatest width just back of middle.

Length.—8.0 mm. Elytra and pronotum with broadly offset and flattened margins. Elytral epipleurae from base to just beyond the end of metasternum with a narrowing horizontal part which is bent outward vertically down. The vertical part considerably wider than the horizontal part, where the latter exists and continuing slightly diminished in width and not quite so vertical to the apex.

Mandibles.—Apical tooth trifid, with the two outer components rudimental. Three lateral teeth present, the second about the size of the apical tooth, the third small, both slender and attached to the

upper side of the rim. The first lateral tooth is considerably larger than any of the others, attached to the lower part of the rim of the mandible between the apical and second lateral and pointing downward. It carries on its lower edge a small side tooth, and beyond that to the apex several small dentules.

Color and maculation.—Under side black, with some lighter parts on the lighter specimen. Maculation of pronotum and elytra, see figure 116. The other specimen has the light portion much more extended so that the ground color appears to be light reddish brown with irregular black markings. Almost all the light spots of figure 116 connected except that a zigzag-shaped black band separates completely the region of the apical light spots from the others. The dark spots appearing in the centers of the light ones are less dark. Covered above and below with long light-gray pubescence, which is sparser in the dark spots of the elytra. The dark spots on the center of the light patches have, however, the pubescence in full strength, and also their ground color seems to be somewhat lighter than that of the connected black parts. Mouth parts, antennae, and legs reddish.

Type locality.—Szechwan and Tibet.

Material examined.—2 female specimens: China, Szechwan Prov., southwest of Tatsienlu, June 28-July 2, 1923 (D. C. Graham, NM).

Remarks.—The form of the epipleurae, together with the absence of abdominal lines, differentiates this species from all other known oriental Epilachninae, and this species is therefore made the type of the new genus *Epiverta.*

Mader, in the original description of *Solanophila chelonia,* does not mention either of these two characters. There seems, however, little doubt that the species described by him is the same as the two specimens before me. He describes the maculation of the elytra as of dark background with 14 light spots arranged 2, 4, 4, 1, 2, 1, which may be interpreted as figure 116 with the light color less developed.

The following two well-known European species of the Epilachninae are included in order to present the structure of abdomen and genitalia of these species in the same manner as for the rest of the subfamily.

SUBCOCCINELLA VIGINTIQUATTUORPUNCTATA (Linnaeus)

FIGURES 1 D, 170

Coccinella 24-punctata LINNAEUS, 1758, p. 366.

Abdomen.—Abdominal lines incomplete, reaching to within one-fourth to one-third of the hind margin of the first segment and

outer part reaching to about one-third of the front margin. Broadly curved. Fifth segment, male, subtruncate or slightly convex; female, with a process in the middle. Sixth segment, male, subtruncate, wide; female, hind margin convex and narrower.

Male genitalia.—Penis 0.6 mm. long, 0.25 mm. in maximum width, approximately in the form of a wooden shoe, basal part open, upper side a clear membrane; apical part closed, ending in a blunt point. No hairs on the penis. Paramera slender, 0.55 mm. long, clothed with fine pubescence practically on their whole length, at least on the outside part. Sipho rather thick (0.1 mm.), bent about 90° near base and apex. Orifice terminal, on the inner side with a long (0.2 mm.) sclerotized needlelike process; on the outer side with membranous flaps.

Female genitalia.—Tergite X wide, hind margin subtruncate or mildly convex with a very slight emargination in the middle. Only a narrow strip along each side of the apical margin with pigment. Plates 0.3 mm. long, widest (0.23 mm.) near apex. The genitalia are in shape most like figure 218, but the greatest width of the plates is nearer the apex, which is more truncate, while the basal part is rounded.

Mandibles (fig. 1 D).—With an apical tooth and two big lateral teeth, the second somewhat smaller than the first. Dentules on all three teeth and the inner margin.

CYNEGETIS IMPUNCTATA (Linnaeus)

FIGURES 1 H, 171

Coccinella impunctata LINNAEUS, 1767, p. 579.

Abdomen.—Abdominal lines subterminal, subcomplete, outer margin parallel to the side margin of the first segment and close to it. Fifth segment, male, hind margin convex; female, truncate. Sixth segment, male, hind margin emarginate; female, convex.

Male genitalia.—Penis a very flattened tube almost straight in profile, 0.55 mm. long; seen from below widened from base to apex, widest part 0.3 mm., then suddenly narrowed to rounded tip. Paramera 0.7 mm. long, slender, gently curved down, 0.1 mm. wide at about four-fifths of their length, covered with hairs on apical part. Sipho curved, orifice with a liplike process bordered by very short bristles, which are clearly visible only at fairly high magnifications (50× or higher).

Female genitalia.—These look in general structure much more like those of some *Epilachna* species than *Afissa* species. Plates 0.45 mm.

long, greatest width 0.22 mm. about one-third way from the apex. The general shape of the plates is not unlike that of figure 185, with the apical part more rounded and without the emargination on the inner edge. Tergite X with convex hind margin, the middle a clear, membranous, wide strip, on each side pigmented strips, which do not quite touch in the middle of the apical margin.

Mandibles (fig. 1 H).—With an apical and two lateral teeth. The apical tooth, as in most other Epilachninae, has the middle part much more strongly developed than the side parts. The lateral teeth are relatively short, the second smaller than the first. There are very small dentules on the teeth (clearly visible only with about 50× magnification). The structure of the mandibles conflicts with the description by Ganglbauer (1899, p. 951) who claims that there is only one trifid tooth. He must have examined a specimen with the two lateral teeth broken off.

As the material from China and the Philippines that I had a chance to examine was much more extended than anything published previously, I add a list of all the known Epilachninae of these two regions. A few species unknown to me recorded by others have been added, provided there was no serious doubt about the identity of the species. Type localities are printed in italics.

CHINA

Epilachna sparsa orientalis, new..... Fukien, Kiang-su, Shensi, Hong Kong, Szechwan, Anhwei.
var. *cinerea,* new..... Fukien, Kiang-su, Szechwan.
dentulata, new..... Fukien, Kiang-su. (*Cochin China.*)
niponica Lewis .... Chih-li, Kiang-su, Jehol, Manchuria, Hopei, Korea. (*Japan.*)
coalescens Mader ..... *Szechwan.*
libera, new ..... *Szechwan.*
Afidenta mimetica, new..... Fukien, Shantung, Tibet (*Indochina*), Anhwei, Kwangsi.
bisquadripunctata Gyllenhal ..... Kwangsi, Hong Kong *.
Afissa admirabilis (Crotch)..... Kiang-si, Kiang-su, Chekiang *, Anhwei, Hupei.
continentalis, new ..... *Szechwan.*
macularis (Mulsant) ..... Szechwan. (*Nepal.*)
donckieri Weise ..... *Yunnan,* Tibet.
alternans (Mulsant) ..... Szechwan. (*Java.*)
insignis (Gorham) ..... *China,* Szechwan, Kinkiang *, Anhwei.

* Localities originally given by Liu (1935).

quindecemguttata, new ..... *Szechwan.*
mirabiloides, new ..... *Szechwan.*
quadricollis, new ..... *Chekiang*, Kiang-su.
expansa, new ..... *Szechwan.*
bicrescens, new ..... *Szechwan.*
anhweiana, new ..... *Anhwei.*
chinensis (Weise) ..... *Fo-kien*, Anhwei.
provisoria, new ..... *Szechwan.*
ocellatae-maculata (Mader) ..... *Yunnan*, Szechwan.
plicata (Weise) ..... *Kanssu*, Szechwan.
completa, new ..... *Szechwan.*
lugubris, new ..... *Shantung.*
complicata, new ..... *Szechwan.*
sustenans, new ..... *Szechwan.*
convexa, new ..... *Szechwan.*
hauseri (Mader) ..... *Yunnan*, Szechwan, Shantung.
dobzhanskyi, new ..... *Shantung.*
szechuana, new ..... *Szechwan.*
subacuta, new ..... *Szechwan.*
magna, new ..... *Fukien.*
Epiverta chelonia (Mader) ..... *Szechwan.*

The check list of the Coccinellidae of China by Liu (1935) contains 18 species of *Epilachna* in addition to *Ballida brahamae*, described by Mulsant from a single specimen in bad condition and not observed by anyone since. Whether this species actually belongs to the Epilachninae needs checking.

The species of *Epilachna* and *Afissa* in Liu's list not observed by me are:

Epilachna indica Mulsant.
28-punctata (Fabricius).

The identity of these two species is more than questionable. They are probably confused with *sparsa, dentulata, niponica,* and possibly *Afidenta mimetica.*

Afissa acuta (Weise) ..... *Kansu.*
sanscrita (Crotch) ..... Kiang-si, Kiautschau. (*India.*)
11-spilota (Hope) ..... Hong Kong *. (*Nepal.*)
dumerili (Mulsant) ..... Hong Kong *. (*East Indies.*)
10-maculata (Redtenbacher) ..... (*Kashmir.*)

There may be some doubt about the identification of *11-spilota* and *dumerili* (cf. pp. 136, 137, 138). There is also doubt about *10-maculata* (Redtenbacher) occurring in China. It may have been confused with another species of similar appearance.

* Localities originally given by Liu (1935).

PHILIPPINE ISLANDS

Epilachna philippinensis, new ..... *Luzón.*
remota, new ..... Bohol, Jolo, Luzón, *Mindanao*, Negros, Palawan (New Guinea?).
dentulata new ..... Luzón (*Cochin China*, China, Flores).
parvinotata, new ..... *Mindanao*, Mindoro, Negros, Samar, Sulu.
reducta, new ..... *Luzón.*
emarginata, new ..... *Samar.*
altera, new ..... *Luzón.*
bakeri, new ..... Biliran, *Mindanao*, Panay, Pohilo.
luzonica, new ..... *Luzón.*
diffinis (Eydoux and Souleyet) ..... Banaran, Basilan, Luzón, Mindanao.
signatula Mulsant ..... Palawan, Sulu.
elongata, new ..... *Mindanao.*
mindanaonis, new ..... *Mindanao*, Samar.
pytho Mulsant ..... Mindanao. (*Java, Sumatra.*)
pytharga, new ..... *Luzón.*
hemispherica, new ..... Mindanao, *Luzón.*
diversa new ..... *Luzón.*
boisduvali Mulsant ..... Mindanao, Luzón, Tayabas. (*Australia.*)
baguiana, new ..... *Luzón.*
biroi Weise ..... Luzón. (*New Guinea.*)
Afissa flavicollis (Thunberg) ..... Basilan, Biliran, Jolo, Luzón, Mindanao. (*East Indies.*)
chapini, new ..... *Luzón*, Mindanao.

The catalog of Philippine beetles by Schultze (1915, p. 43) lists the following species:

Epilachna pusillanima Mulsant ..... Luzón, Mindoro, Ticao, Negros, Mindanao, Palawan.
pytho Mulsant ..... *Luzón.*
28-punctata (Fabricius) ..... Luzón, Sabtan.

It quotes in addition the Mulsant (1850) record of *Epilachna diffinis* with the varieties *signatula* Mulsant and *stolida* Mulsant.

Schultze's *pusillanima* record probably refers to *diffinis*, and the reasons for this are given under *diffinis* in the present paper. Schultze's *28-punctata* record very probably belongs to *E. philippinensis* or *dentulata* or both. The extension of the number of known Philippine epilachnine species from 3 to 17 forms a considerable increase in the knowledge of the coccinellid fauna of the Philippine Islands.

It is interesting to compare the lists of China and the Philippine Islands. There is only one species (*dentulata*) common to both lists. In China the list is predominantly made up of *Afissa* species, in the Philippines almost exclusively of *Epilachna* species. With the one exception, the nearest relatives of the Philippine Epilachninae, either the same species sometimes represented by a different subspecies or closely related species, are found on the islands to the west and south. However, much more material will have to be collected from the surrounding regions before anything like a detailed picture of the geographical distribution of the various species can be drawn, from which, then, conclusions might be drawn about the development and expansion of the genus in early times.

BIBLIOGRAPHY

(The nature of the article in each case is indicated by the following abbreviations: T, taxonomic; N, containing descriptions of new species of Epilachninae; M, morphological; B, biological; L, geographical lists; G, genetic.)

ANONYMOUS.
1932. The potato beetle (a serious pest of the potato crop). Mysore [India] State Dep. Agr. Circ. 49, pp. 1-4, 2 figs. B.

ARROW, GILBERT JOHN.
1900. Coleoptera of Christmas Island: Coccinellidae. *In* "A Monograph of Christmas Island (Indian Ocean)," pp. 95-96. TN.

BARBER, H. S., and BRIDWELL, J. C.
1940. Dejean Catalogue names (Coleoptera). Bull. Brooklyn Ent. Soc., vol. 35, No. 1, pp. 1-12.

BLACKBURN, THOMAS.
1895. Further notes on Australian Coleoptera, with descriptions of new genera and species (XVII). Trans. Roy. Soc. South Australia, vol. 9, pp. 201-258. TN.

BOISDUVAL, JEAN B.
1835. Voyage de découvertes de l'*Astrolabe* . . . Faune entomologiques, pt. 2: Coléoptères, 716 pp. TN. (Plates published in 1832.)

CHATTERJEE, N. C., and BOSE, B.
1933. Entomological investigations on the spike disease of sandal (17): Coccinellidae (Col.), supplementary data. Indian For. Rec., vol. 19, pt. 7, 10 pp. LB.

CHEVROLAT, A.
1837. *In* Dejean's "Catalogue des Coléoptères . . . ," ed. 3, pp. 460-461. T.

CHUE, C. C.
1928. Some biological notes on a leaf-feeding coccinellid (*Epilachna 28-punctata* Fabr.). Lingnan Sci. Journ., vol. 6, pp. 301-313, 2 pls. B.

CROTCH, GEORGE ROBERT.
1874. A revision of the coleopterous family Coccinellidae, 311 pp. TN.

Della Beffa, G.
1912. Revisione dei Coccinellidi italiani. Rev. Coleotter. Ital., vol. 11, pp. 145-192, 2 pls. T.
1913. Revisione dei Coccinellidi Italiani. I. Epilachninae, Coccinellinae. 251 pp., 7 pls. T.

Dobzhansky, Th.
1924. Die weiblichen Geschlechtsorgane der Coccinelliden als Artmerkmal betrachtet. Ent. Mitt., vol. 13, pp. 18-26. MT.
1926. Les organes génitaux des Coccinellidae comme caractère taxonomique [in Russian]. Bull. Acad. Sci. URSS, ser. 6, vol. 20, pp. 1385-1394, 1555-1586, 2 pls. MT.

Eydoux, J. F. T., and Souleyet, F. L. A.
1839. Descriptions sommaires de quelques coléoptères nouveaux, provenant de Manille et destinés à être publiés dans le Voyage autour du monde de la corvette *la Bonite*. Rev. Zool., vol. 2, pp. 264-267. TN.

Fabricius, Johan Christian.
1775. Systema entomologiae . . . , 832 pp. TN.
1781. Species insectorum . . . , vol. 1, 552 pp. T.
1787. Mantissa insectorum . . . , vol. 1, 348 pp. T.
1792. Entomologia systematica emendata et aucta . . . , vol. 1, 538 pp. T.

Fauvel, A.
1903. Faune analytique des coléoptères de la Nouvelle Caledonie. Rev. d'Ent., vol. 22, pp. 203-378. LT.

Fletcher, Thomas Bainbridge.
1914. Some South Indian insects and other animals of importance considered especially from an economic point of view, 546 pp., 50 pls. B.

Fourcroy, Antoine François de.
1785. Entomologia Parisiensis, pt. 1, 231 pp. TN.

Ganglbauer, Ludwig.
1899. Die Käfer von Mitteleuropa, vol. 3, 1,046 pp., 46 figs. T.

Geoffroy, E.
1762. Histoire abregee des insectes qui se trouvent aux anvirons de Paris, p. 325.

Gorham, H. S.
1892. Coleoptera from central China and the Korea. Entomologist, vol. 24 (Suppl.), pp. 81-85. TN.
1894a. On the Coccinellidae from India in the collection of Mr. H. E. Andrewes of the Indian Forest Service. Ann. Soc. Ent. Belgique, vol. 38, pp. 200-208. TN.
1894b. Observations on some species of the family Coccinellidae collected near Konbir and Mandar, India, Bengal, by P. Cardon. Ann. Soc. Ent. Belgique, vol. 38, pp. 209-211. TN.
1895. On the Coccinellidae collected by Mr. L. Fea in Birma. Ann. Mus. Civ. Genova, ser. 2, vol. 34, pp. 683-695. TN.
1903. On the Coleoptera collected in India by MM. H. E. and H. L. Andrewes. Ann. Soc. Ent. Belgique, vol. 47, pp. 323-347. TN.

GUÉRIN-MÉNEVILLE, F. E.
1840. Coléoptères nouveaux du plateau des Neelgheries, dans les Indes orientales, découverts par M. Adolphe Delessert, et décrits par M. Guérin-Méneville. Rev. Zool., vol. 3, pp. 37-42. TN.

HERBST, J. F. W.
1786. Erste Mantisse zum Verzeichniss der ersten Klasse meiner Insektensammlung. Füessly's Archiv der Insectengeschichte, vol. 6, pp. 153-182, 6 pls. TN.

HOPE, F. W.
1831. Synopsis of the new species of Nepaul insects in the collection of Major General Hardwicke. Gray's Zoological Miscellany, pp. 21-32. TN.
1840. Coleopterist's manual, vol. 3, 191 pp., 3 pls. T.

KAWANO.
1934. *Epilachna admirabilis,* morphology, biology [in Japanese]. Kontyu, vol. 8, pp. 138-152. MB.

KLEMM, M.
1930. Beitrag zur Morphologie und Biologie der Epilachna chrysomelina Fabr. (Coleopt.). Zeitschr. für wiss. Insektenbiol., vol. 24, pp. 231-251, 14 figs., 3 pls. MB.

KÔNO, HIROMICHI.
1937. Eine neue *Epilachna*-Art, Ins. Mats., vol. 11, No. 3, p. 99, 1 fig. N.

KORSCHEFSKY, R.
1928. Bemerkungen über exotische Coccinelliden der alten Welt mit Beschreibung einer neuen Art. Ent. Mitt., vol. 17, pp. 41-42. TN.
1931. Coccinellidae I. Coleopterorum catalogus . . . , pars 118, 224 pp. T.
1933a. Synonymische und andere Bemerkungen über Crotch'sche Coccinelliden-Type. Stylops, vol. 11, pp. 236-237. T.
1933b. Bemerkungen über Coccinelliden von Formosa. Trans. Nat. Hist. Soc. Formosa, vol. 23, pp. 299-304. T.
1933c. Entomological investigations on the spike disease of sandal (16): Coccinellidae (Col.). Indian For. Rec., vol. 19, pt. 6, 9 pp. TN.

LEMAN, G. CURTIS.
1927. Some observations on coccinellids and new aberrations. Ent. Rec. and Journ. Var., vol. 39, pp. 66-67. TN.

LEWIS, G.
1896. On the Coccinellidae of Japan. Ann. Mag. Nat. Hist., ser. 6, vol. 17, pp. 22-41. TN.

LINNAEUS, CAROLUS.
1758. Systema naturae, ed. 10, vol. 1, 824 pp. TN.
1767. Systema naturae, ed. 12, pt. 2, pp. 533-[1364]. TN.

LIU, CH.
1935. A check list of Coccinellidae of China. Ent. and Phytopath., vol. 3, pp. 294-304. L.

MADER, LEOPOLD.
1926. Die Evidenz der palaearktischen Coccinelliden. T.
1930. Neue Coccinelliden aus Yün-nan und Sze-tschwan (China). Ent. Anz., vol. 10, pp. 161-166, 181-184, 11 figs. TN.
1933. Über bekannte und neue Coccinelliden. Ent. Anz., vol. 13, pp. 79-84. TN.

MONTROUZIER, XAVIER.
1855. Essai sur la faune l'île de Woodlark ou Moiou. Ann. Sci. Phys. et Nat. Soc. Agr. Lyon, ser. 2, vol. 7, pp. 1-114. TN.
MOTSCHULSKY, VICTOR DE.
1857. Insectes du Japon. Êtudes Entmologiques, No. 6, pp. 25-41. TN.
MULSANT, ETIENNE.
1846. Histoire naturelle des coléoptères de France: Sulcicolles—Sécuripalpes, 280 pp., 1 pl. TN.
1850. Species des coléoptères trimères sécuripalpes, 1,104 pp. TN.
1853. Opuscules entomologiques, pt. 3, 205 pp. TN.
OLIVIER, G. A.
1791. Encyclopédie méthodique, vol. 6.
1808. Entomologie . . . : Coleoptera, vol. 6, No. 98, pp. 985-1,061, 7 pls. T.
OLLIFF, A. S.
1890. The leaf-eating lady-bird (*Epilachna vigintioctopunctata* Fabr.). Agr. Gaz. New South Wales, vol. 1, pp. 281-283. B.
REDTENBACHER, LUDWIG.
1843. Tentamen dispositionis generum et specierum coleopterorum pseusotrimerorum Archiducatus Austriae. T.
1844. Coleoptera. *In* C. F. von Hügel's "Kaschmir und das Reich der Siek," vol. 4. pt. 2, pp. 497-564, 6 pls. TN.
REH, L.
1913. *In* Sorauer's "Handbuch der Pflanzenkrankheiten," vol. 3, 774 pp., 306 figs. (Epilachninae, pp. 476-478). B.
REITTER, EDMUND.
1908. Fauna Germanica: Die Käfer des Deutschen Reiches, vol. 1, 248 pp., 40 pls.
1911. *Idem,* vol. 3, 436 pp., 147 figs., 48 pls.
ROSSI, PETER.
1794. Mantissa insectorum . . . , pt. 2, 154 pp., 8 pls. TN.
SCHÖNHERR, CARL JOHANN.
1808. Synonymia insectorum . . . , vol. 1, pt. 2, 424 pp., 4 pls. TN.
SCHULTZE, W.
1915. A catalogue of Philippine Coleoptera, 198 pp. L.
SICARD, A.
1907. Coléoptères coccinellides du Japon recueillis par MM. Harmand et Gallois. Bull. Mus. Hist. Nat. Paris, 1907, pp. 210-212. L.
1910. Coccinellides de l'Inde. Ann. Soc. Ent. France, vol. 79, pp. 377-389. TN.
1912a. Notes sur quelques coccinellides de l'Inde et de Birmanie appartenant à la collection de M. Andrewes, de Londres, et description d'espèces et de variétés nouvelles. Ann. Soc. Ent. France, vol. 81, pp. 495-506. TN.
1912b. Coccinellides nouveaux de la collection de M. Walter, de Rägern (Moravie). Ann. Soc. Ent. France, vol. 81, pp. 507-513. TN.
1912c. Descriptions d'espèces et variétés nouvelles de coccinellides de la collection du Deutsches Entomolgisches Museum de Berlin-Dahlem. Arch. für Naturg., Jahrg. 78A, No. 6, pp. 129-138. TN.

1925. Descriptions de coccinellides appartenant à la collection de M. Andrewes de Londres. Ann. Mag. Nat. Hist., ser. 9, vol. 15, pp. 447-449. TN.

STRASBURGER, E. H.

1936. Über Störungen der Eientwicklung bei Kreuzungen von *Epilachna chrysomelina* F. mit *Epilachna capensis* Thunb. Zeitschr. für wiss. Abst. und Vererbgsl., vol. 71, pp. 538-545. G.

SULZER, JOHAN HEINRICH.

1776. Abgekürzte Geschichte der Insecten nach dem Linnéischen System, pt. 1, 274 pp. TN.

TAKAGI and ITO.

1932. [*Epilachna niponica,* morphology, biology.] Fukushima Agr. Exp. Stat., 50 pp. MB. (Not seen.)

TAKAHASHI, S.

1932. Study of *Epilachna* lady beetles in Japan. Journ. Tokyo Mogyo Daigaku, vol. 3, pp. 1-115. MBG.

TANABE, SEKIYA, and KUMAGAYA.

1934. *Epilachna niponica,* bionomics [in Japanese]. Rep. Nagano Agr. Exp. Stat. No. 5, 71 pp. B. (Not seen.)

TEMPERLEY, MARGARET E.

1928. The leaf-eating ladybird. 8 pp., 1 col. pl. Dep. Agr. and Stock, Queensland. B.

TENENBAUM, E.

1931. Variabilität der Fleckengrösse innerhalb der Palästinarasse von *Epilachna chrysomelina.* Die Naturw., vol. 19, pp. 490-493. G.

1933. Zur Vererbung des Zeichnungsmusters von *Epilachna chrysomelina* F. Biol. Zentralbl., vol. 53, pp. 308-313. G.

THUNBERG, CARL PEHR.

1781. Dissertatio entomologica: Novas insectorum species . . . , pt. 1, 28 pp., 44 figs. TN.

TIMOFEEF RESSOVSKY, H. A.

1935. Divergens, eine Mutation von *Epilachna chrysomelina* F. Zeitschr. für ind. Abst. und Vererbgsl., vol. 68, pp. 443-453. G.

VERHOEFF, C.

1895. Beiträge zur vergleichenden Morphologie des Abdomens der Coccinelliden. Arch. für Naturg., Jahrg. 61, pp. 1-80. M.

WEISE, JULIUS.

1879. Bestimmungs-Tabellen der europäischen Coleopteren. II: Coccinelliden. Zeitschr. Ent., vol. 7, pp. 88-156. TN.

1889. Insecta, a Cl. G. N. Potanin in China et Mongolia novissime lecta. IX: Chrysomelidae et Coccinellidae. Horae Soc. Ent. Ross., vol. 23, pp. 560-653. TN.

1895. Neue Coccinelliden, sowie Bemerkungen zu bekannten Arten. Ann. Soc. Ent. Belgique, vol. 39, pp. 120-146. TN.

1898a. Coccinelliden aus Kamerun. Deutsche Ent. Zeitschr., 1898, pp. 97-125. T.

1898b. Über bekannte und neue Coccinelliden. Arch. für Naturg., Jahrg. 64I, pp. 225-238. TN.

1900. Coccinelliden aus Ceylon gesammelt von Dr. Horn. Deutsche Ent. Zeitschr., 1900, pp. 417-445. TNB.

1901a. Contributions à l'étude de la faune entomologique de Sumatra, Coccinellides. Ann. Soc. Ent. Belgique, vol. 45, pp. 91-96. TN.

1901b. Neue Coccinelliden. Ann. Soc. Ent. Belgique, vol. 45, pp. 273-286. TN.

1902. Coccinelliden aus der Sammlung des Ungarischen Nationalmuseums. Termés. Füz., vol. 25, pp. 489-520. TN.

1903. Neue Coccinelliden. Deutsche Ent. Zeitschr., 1903, pp. 229-232. TN.

1908. Coleopteren aus Ostindien. Stett. Ent. Zeit., vol. 69, pp. 214-230. TN.

1910a. Verzeichniss von Coleopteren aus den Philippinen, nebst zwei neuen Arten aus Niederländisch Ostindien. Philippine Journ. Sci., vol. 5D, pp. 139-149. L.

1910b. Über Chrysomeliden und Coccinelliden aus den Philippinen. Philippine Journ. Sci., vol. 5D, pp. 223-232. T.

1912. Über Hispinen und Coccinelliden. Arch. für Naturg., Jahrg. 78A, No. 12, pp. 100-120. TN.

1913. Über Chrysomeliden und Coccinelliden aus den Philippinen, II Teil. Philippine Journ. Sci., vol. 8D, pp. 215-242. T.

1917. Chrysomeliden und Coccinelliden aus Nord Neu-Guinea. Tijdschr. Ent., vol. 60, pp. 192-224. TN.

1923a. Chrysomeliden und Coccinelliden aus Queensland. Ark. för Zool., vol. 15, No. 12, pp. 1-150. TN.

1923b. H. Sauter's Formosa-Ausbeute: Coccinellidae. Arch. für Naturg, vol. 89A, pt. 2, pp. 182-188. TN.

WIEDEMANN, C. R. W.

1823. Zweihundert neue Käfer von Java, Bengalen und dem Vorgebirge der guten Hoffnung. Zool. Mag. (Altona), vol. 2, pp. 1-133. TN.

YUSA, H.

1936. Insects of Jehol—Coccinellidae. Rep. 1st Sci. Exped. Manchukuo, sect. V, div. 1, pt. X, art. 43. LT.

ZARAPKIN, S. R.

1933. Über gerichtete Variabilität bei Coccinelliden, IV: Variation der Fleckengrösse bei einigen Epilachnapopulationen. Zeitschr. für Morph. und Ökol. Tiere, vol. 27, pp. 276-487. G.

1937. Phänoanalyse von einigen Populationen der *Epilachna* Chrysomelina. Zeitschr. für ind. Abst. und Vererbgsl., vol. 73, pp. 282-331. G.

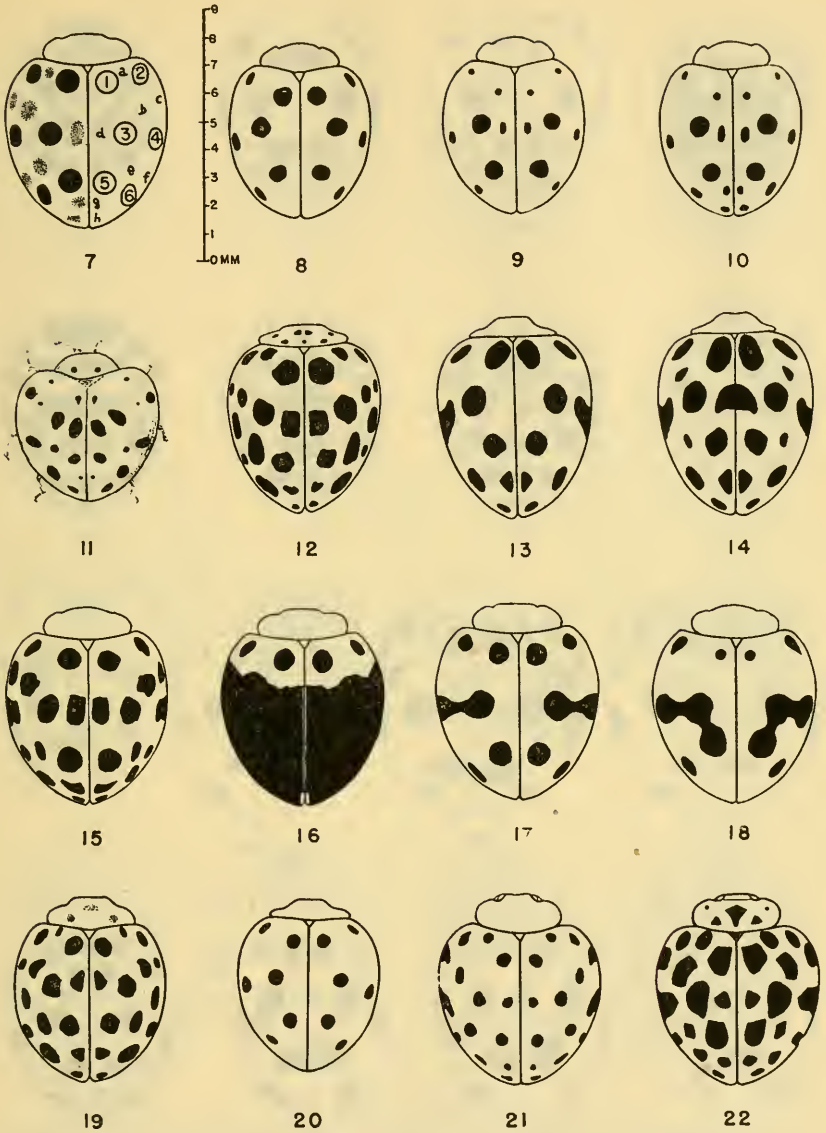
ZARAPKIN, S. R., and TIMOFEEF RESSOVSKY, H. A.

1932. Zur Analyse der Formvariationen, II: Einige Gesetzmässigkeiten in der Variabilität der Fleckenform bei *Epilachna chrysomelina* F. Die Naturw., vol. 20, pp. 384-387. G.

ZIMMERMANN, K.

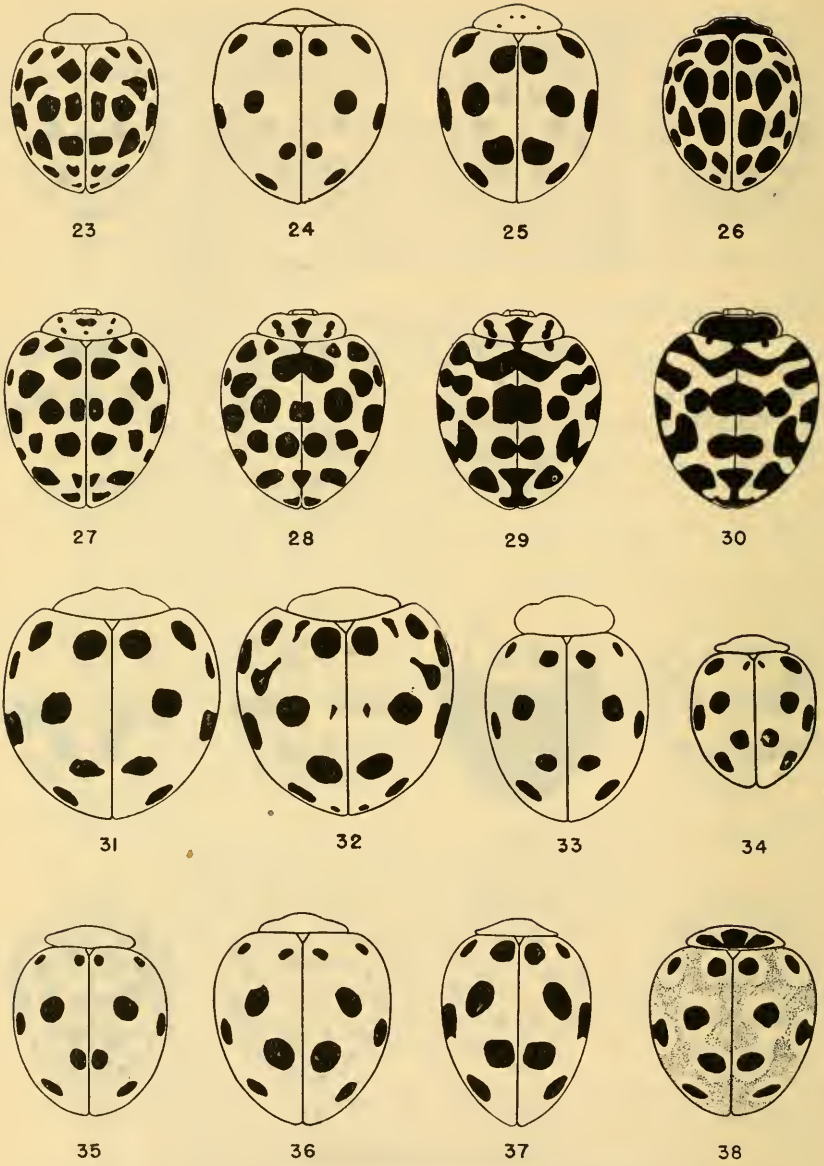
1931. Wirkung von Selektion und Temperatur auf die Pigmentierung von *Epilachna chrysomelina* F. Die Naturw., vol. 19, pp. 768-771. G.

1936. Die geographischen Rassen von *Epilachna chrysomelina* F. und ihre Beziehung zu *Epilachna capensis* Thunbg. Zeitschr. für ind. Abst. und Vererbgsl., vol. 71, pp. 527-537. TG.



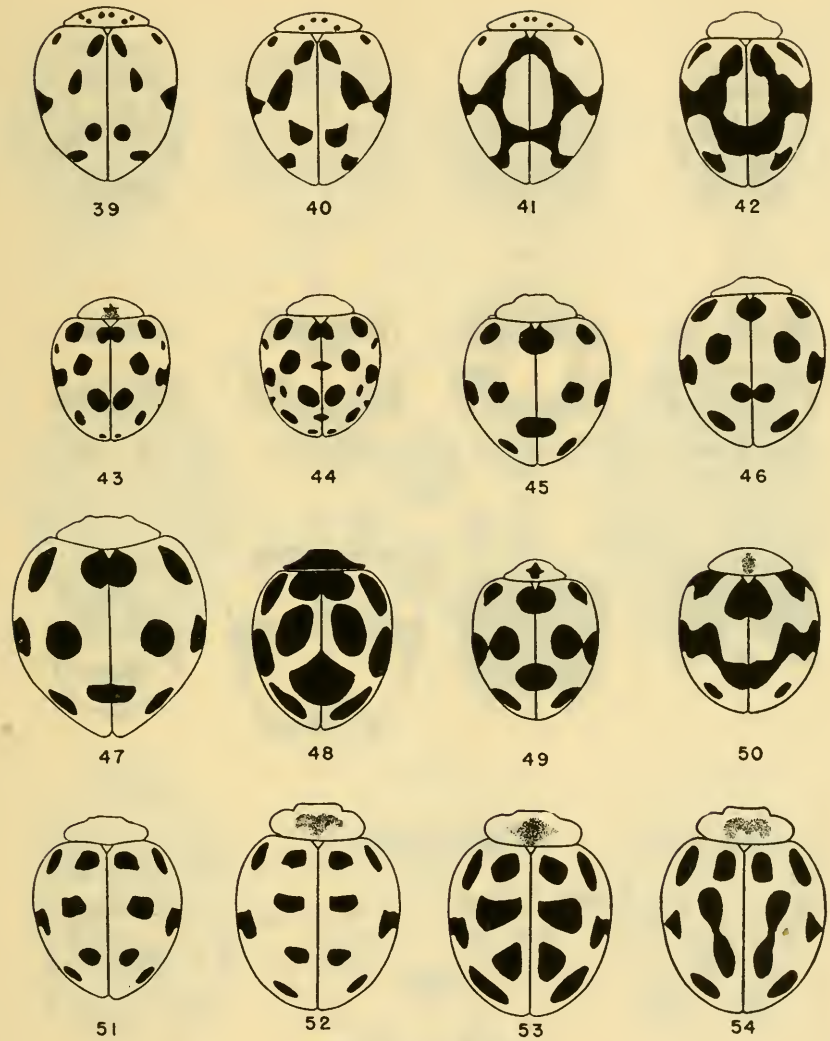
FIGS. 7-22.—*Epilachna.*

7, showing numbering of the persistent (1-6) and nonpersistent (a-h) spots. (Scale for figs. 7-22.) 8-9, *Epilachna sparsa gradaria;* 10, *sparsa sparsa;* 11, *sparsa* (Herbst's original figure, slightly retouched); 12, *sparsa orientalis;* 13-14, *sparsa territa;* 15, *sparsa 26-punctata;* 16, *sparsa* var. *nigrescens;* 17, *sparsa* var. *bijuncta;* 18, *sparsa* var. *trijuncta;* 19, *philippinensis;* 20, *philippinensis remota;* 21-22, *28-punctata.*



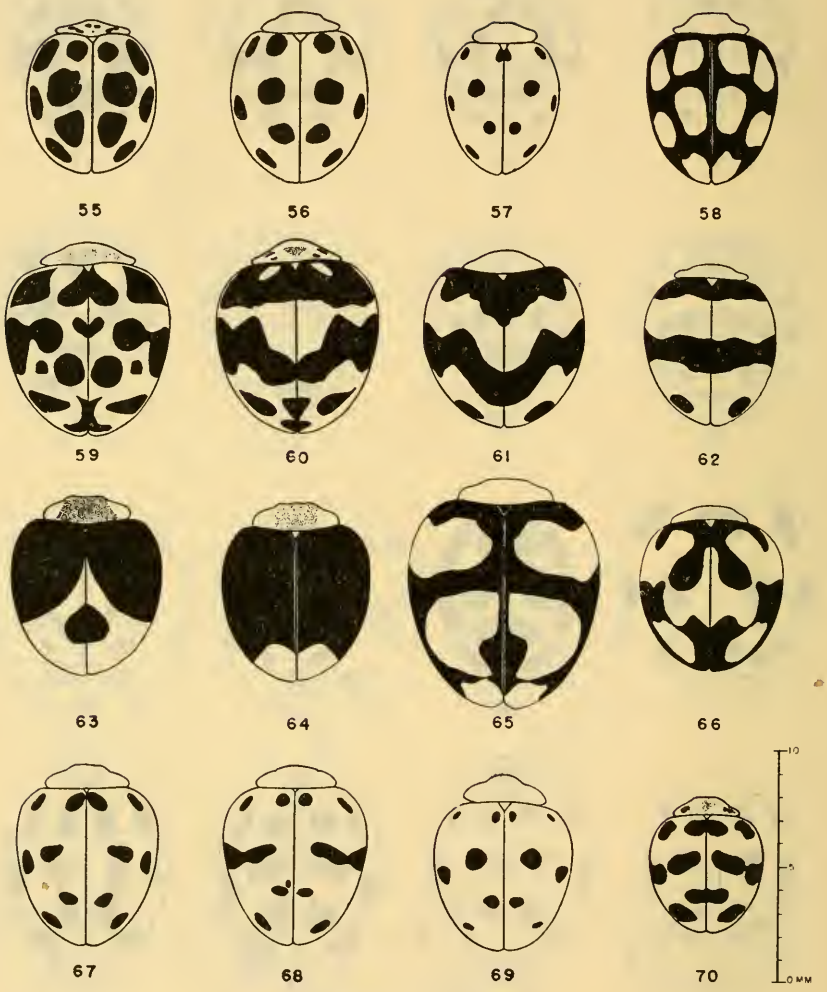
FIGS. 23-38.—*Epilachna.*

23, *Epilachna dentulata;* 24-25, *dentulata parvinotata;* 26, *reducta;* 27-28, *niponica;* 29-30, *niponica coalescens;* 31, *wissmanni* or *bakeri;* 32, *bakeri luzonica;* 33, *diffinis;* 34, *emarginata;* 35, *mindanaonis;* 36, *dubiosa;* 37, *elongata;* 38, *ocellata.*



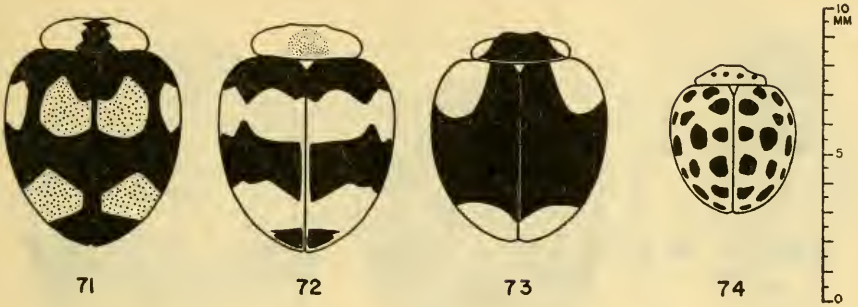
FIGS. 39-54.—*Epilachna.*

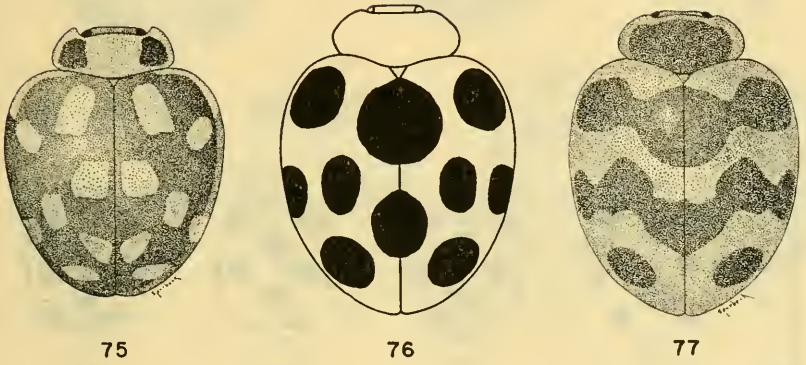
39-40, *Epilachna gangetica;* 41, *gangetica* var. *connecta;* 42, *doryca;* 43-44, *11-variolata;* 45, *pytho;* 46, *pytharga;* 47, *hemispherica;* 48, *diversa;* 49, *perplexa;* 50, *signatipennis;* 51-52, *boisduvali;* 53, *boisduvali fijiensis;* 54, *boisduvali samoana.*



FIGS. 55-70.—*Epilachna.*

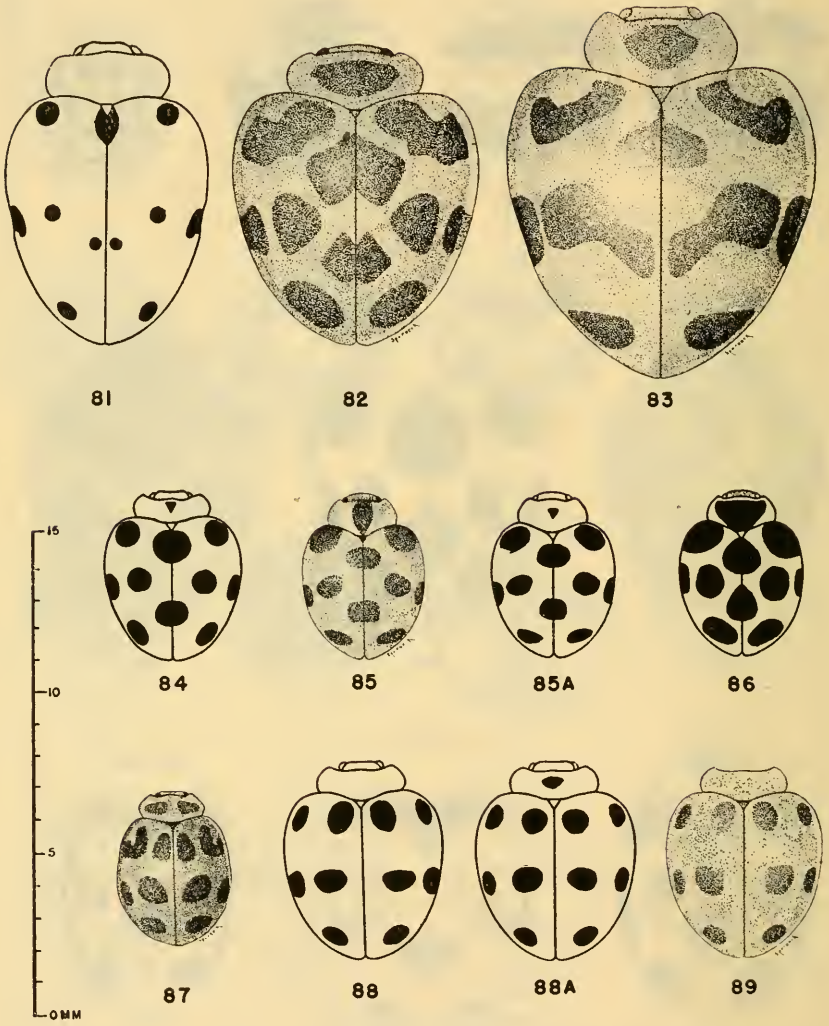
55, *Epilachna baguiana;* 56, *chrysomelina;* 57, *argus;* 58, *delessertii;* 59-60, *libera;* 61, *solomonensis;* 62, *parafasciata;* 63-64, *haemorrhoa;* 65, *deyrollii;* 66, *mjoebergi;* 67-68, *enneasticta;* 69, *indistincta;* 70, *semifasciata.* (Scale for 55-70.)





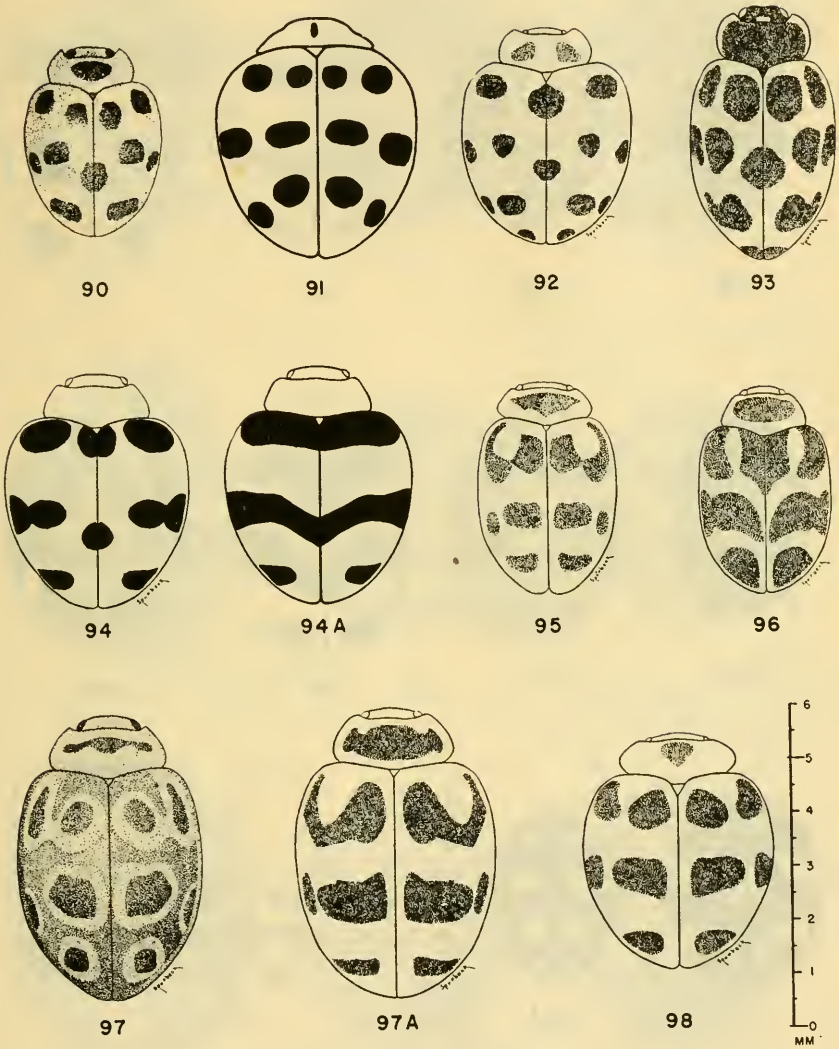
FIGS. 71-80.—*Epilachna, Afidenta,* and *Afissa.*

71, *Epilachna guttatopustulata;* 72, *guttatopustulata tricincta;* 73, *biroi;* 74, *Afidenta mimetica;* (scale for figs. 71-79); 75, *Epilachna laesicollis;* 76, *Afissa admirabilis;* 77, *admirabilis continentalis;* 78, *macularis;* 79, *alternans* (see also fig. 105); 80, *Afidenta minima;* (scale for fig. 80).



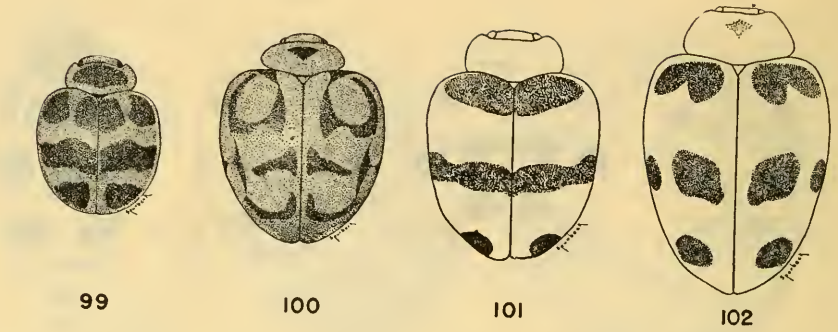
FIGS. 81-89.—*Afissa.*

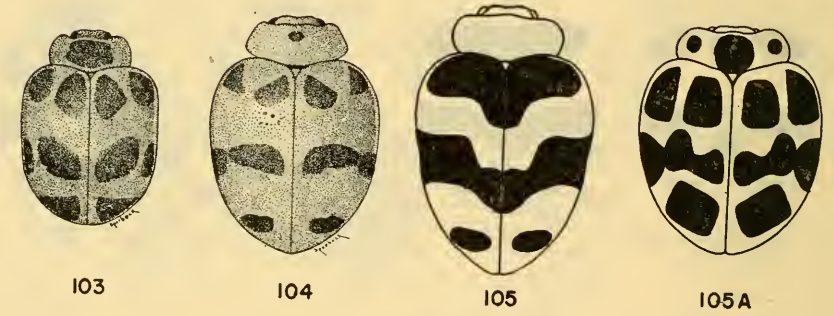
81, *Afissa grayi* (see also fig. 107); 82, *insignis;* 83, *maxima;* 84, *fallax;* 85, *bengalica;* 85A, *maculicollis;* 86, *mirabiloides;* 87, *quadricollis;* 88, *flavicollis;* 88A, *11-spilota;* 89, *coccinelloides.*

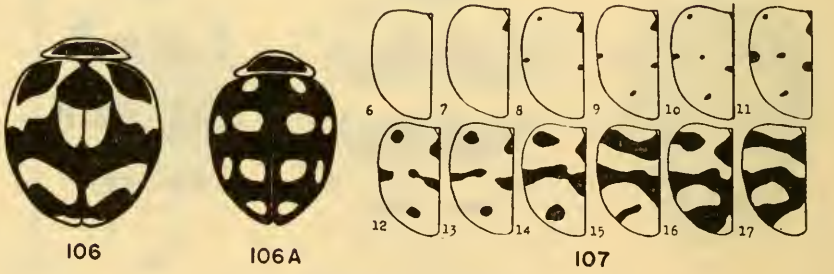


FIGS. 90-98.—*Afissa.*

90, *Afissa manderstjernae;* 91, *atypica;* 92, *siamensis;* 93, *15-guttata;* 94-94A, *gedeensis;* 95, *mysticoides;* 96, *bicrescens;* 97, *ocellatae-maculata;* 97A, *plicata;* 98, *10-guttata.*

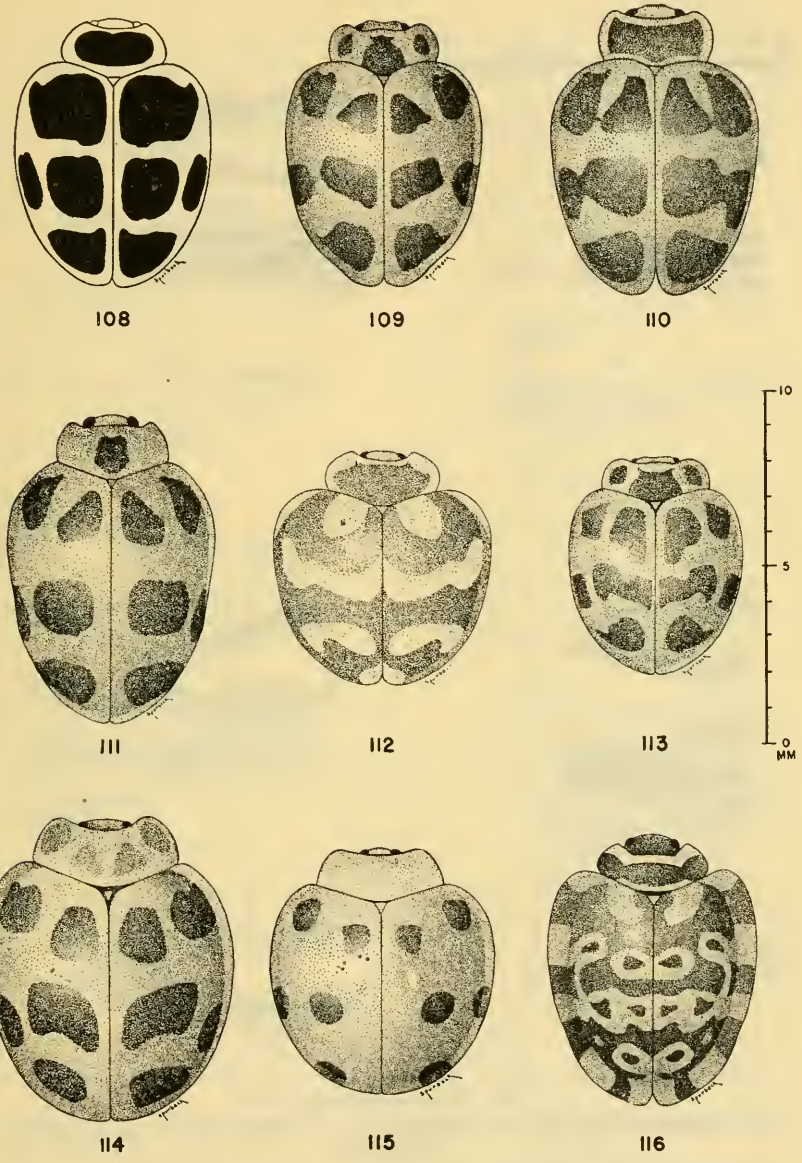






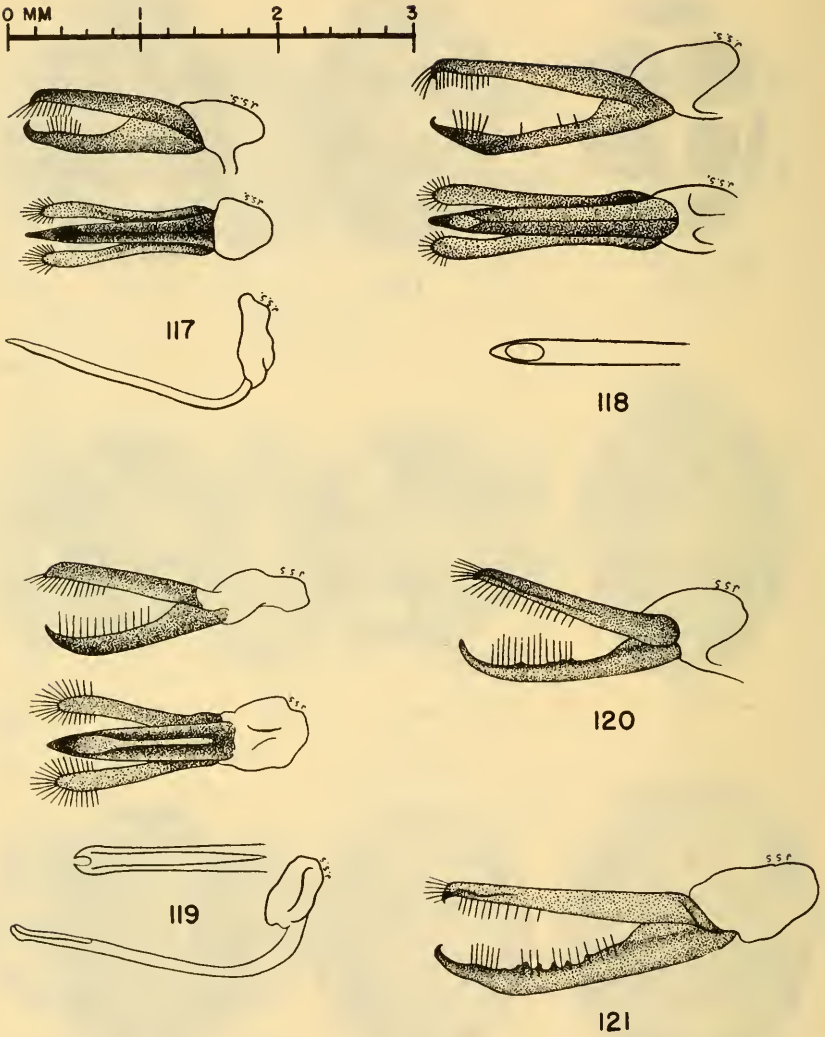
FIGS. 99-107.—*Afissa.*

99, *Afissa expansa;* 100, *mystica;* 101, *orthofasciata;* 102, *annamensis;* 103, *provisoria;* 104, *longissima;* 105, *alternans* (see also fig. 79); 105A, *subacuta;* 106, *captiva;* 106A, *lugubris;* 107, *grayi* (after Korschefsky, 1933).



FIGS. 108-116.—*Afissa* and *Epiverta*.

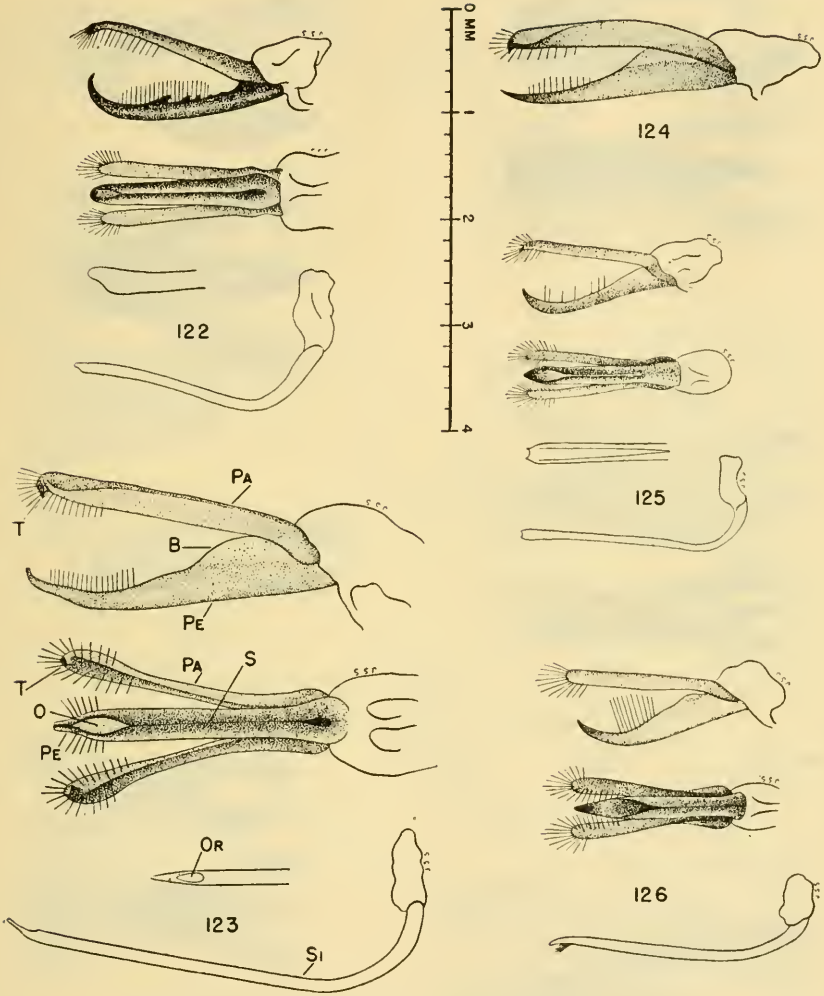
108, *Afissa completa;* 109, *convexa;* 110, *complicata sustenans;* 111, *complicata;* 112, *hauseri;* 113, *szechuana;* 114, *magna;* 115, *chapini;* 116, *Epiverta chelonia.*



FIGS. 117-121.—Male genitalia.

117, *Epilachna sparsa;* 118, *philippinensis;* 119, *28-punctata;* 120, *dentulata;* 121, *diffinis.*

Wherever the shape of the sipho is not indicated, it has approximately the shape of figure 117. The tip of the sipho is usually like figure 118, if no details are given.

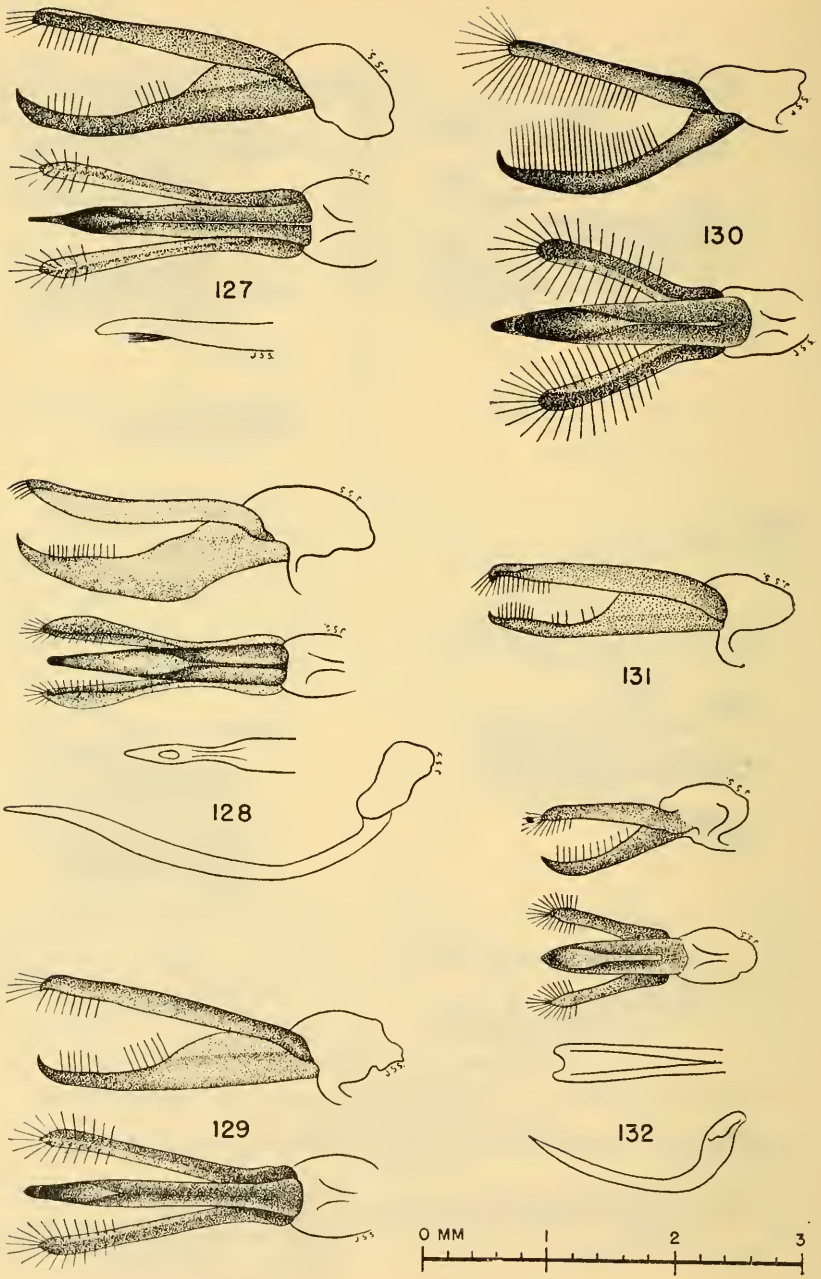


FIGS. 122-126.—Male genitalia.

122, *Epilachna niponica;* 123, *wissmanni;* 124, *bakeri;* 125, *emarginata;* 126, *mindanaonis.*

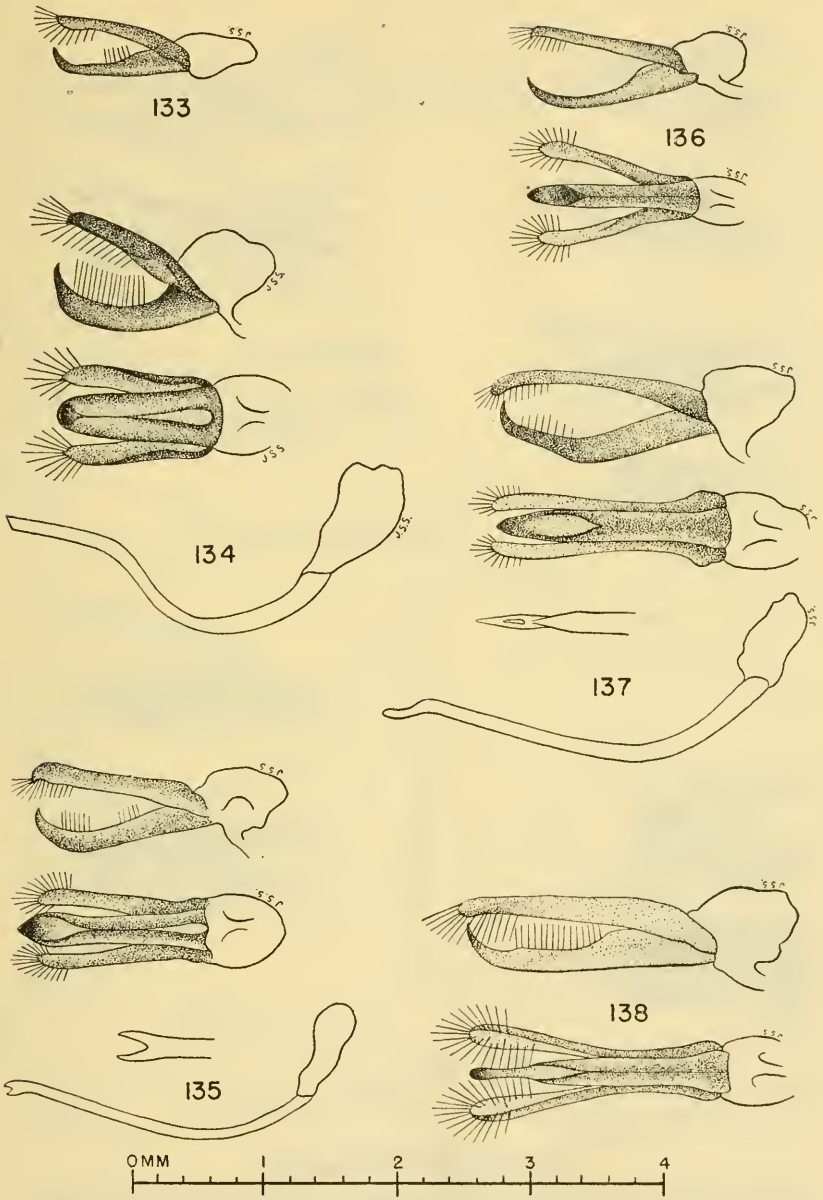
Nomenclature of male genitalia in figure 123 (nomenclature of Sharp and Muir in parentheses) :

B, basal knife edge.
O, orifice of penis through which sipho protrudes.
Or, orifice of sipho.
Pa, Paramera (lateral lobes).
Pe, Penis (adaegus).
S, seam on under side of penis.
Si, sipho (median lobe).
T, apical thorn of paramera.



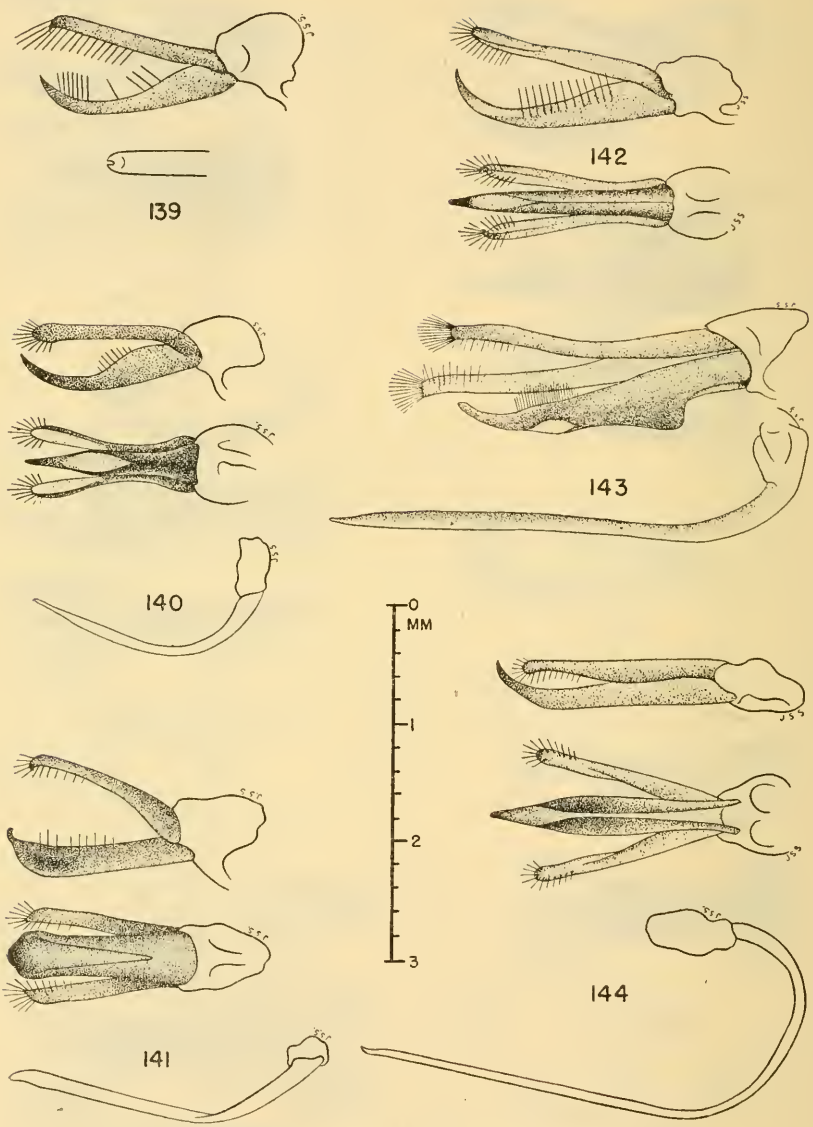
FIGS. 127-132.—Male genitalia.

127, *Epilachna dubiosa;* 128, *tertia;* 129, *pytho;* 130, *hemispherica;* 131, *gangetica;* 132, *signatipennis.*



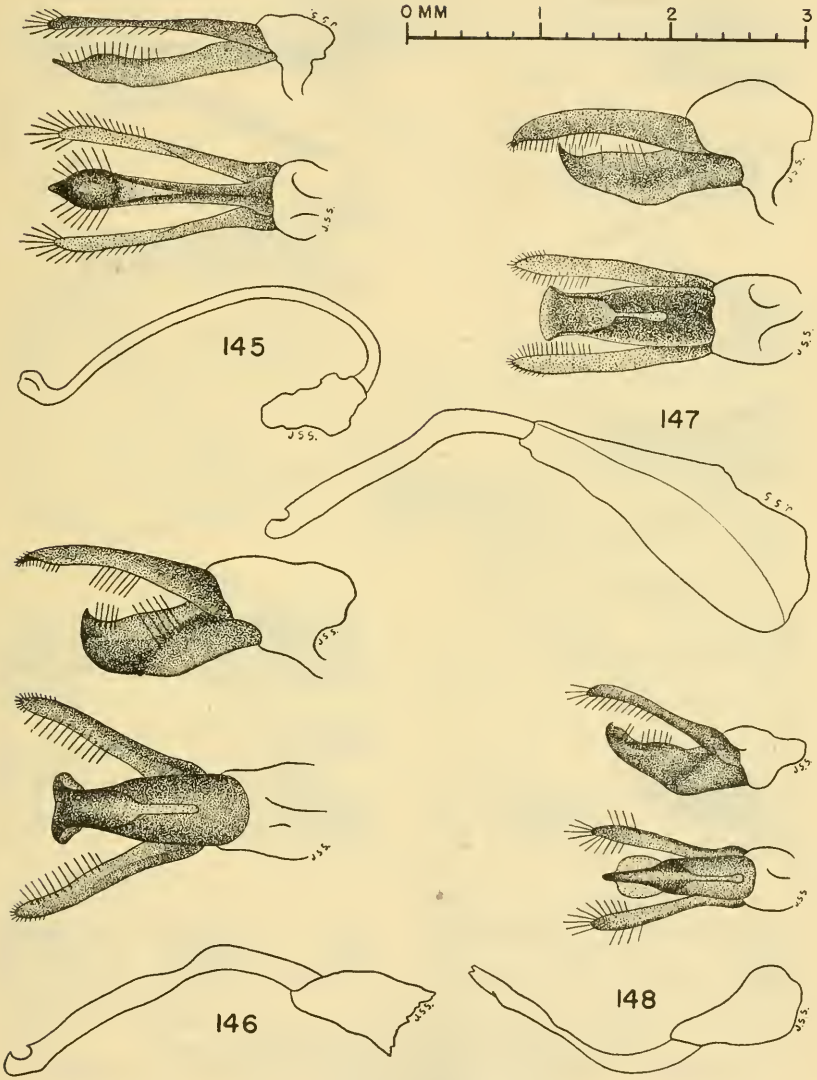
FIGS. 133-138.—Male genitalia.

133, *Epilachna baguiana;* 134, *diversa;* 135, *boisduvali;* 136, *11-variolata;* 137, *delessertii;* 138, *libera.*



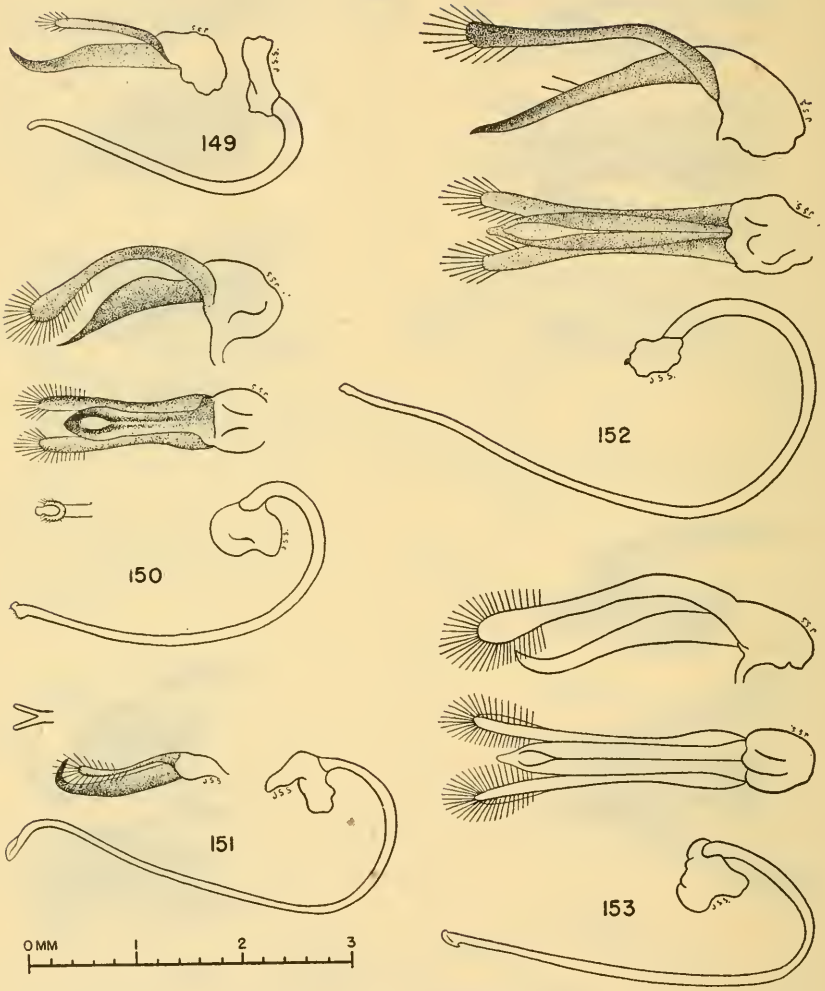
FIGS. 139-144.—Male genitalia.

139, *Epilachna solomonensis;* 140, *haemorrhoa;* 141, *deyrollii;* 142, *mjoebergi;* 143, *laesicollis;* 144, *guttatopustulata.*



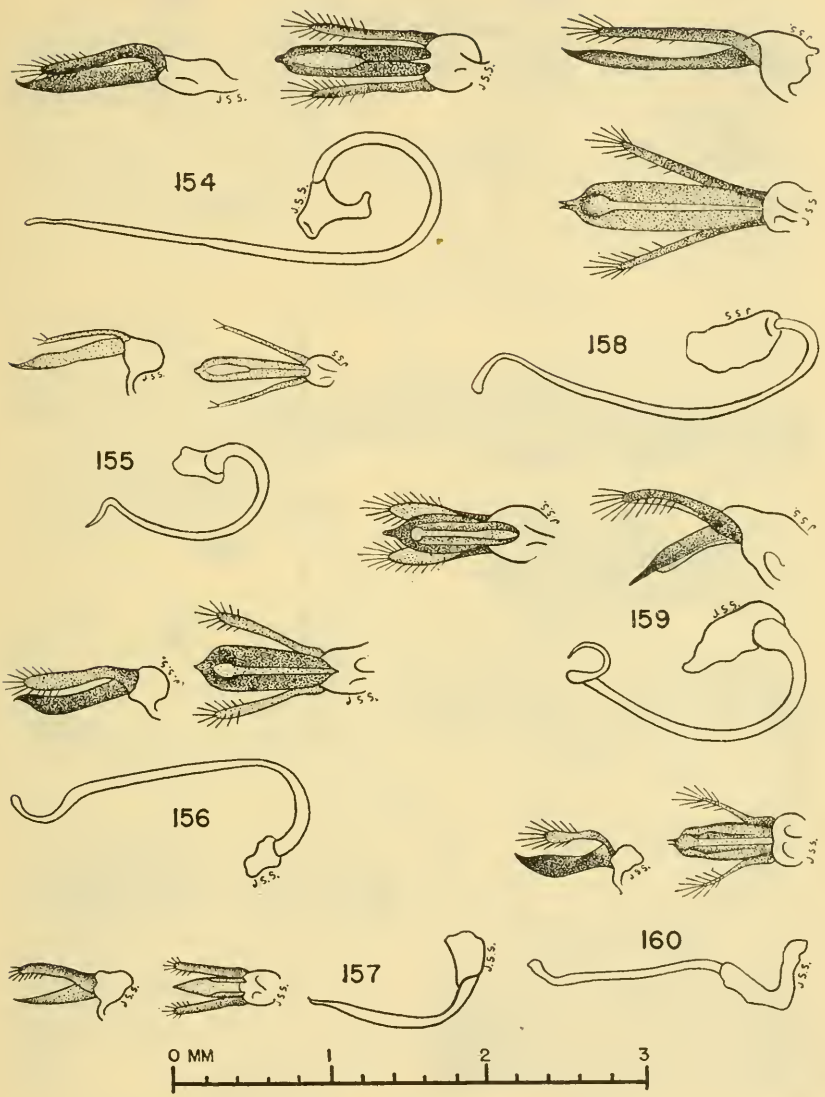
FIGS. 145-148.—Male genitalia.

145, *Epilachna chrysomelina;* 146, *enneasticta;* 147, *indistincta;* 148, *semifasciata.*



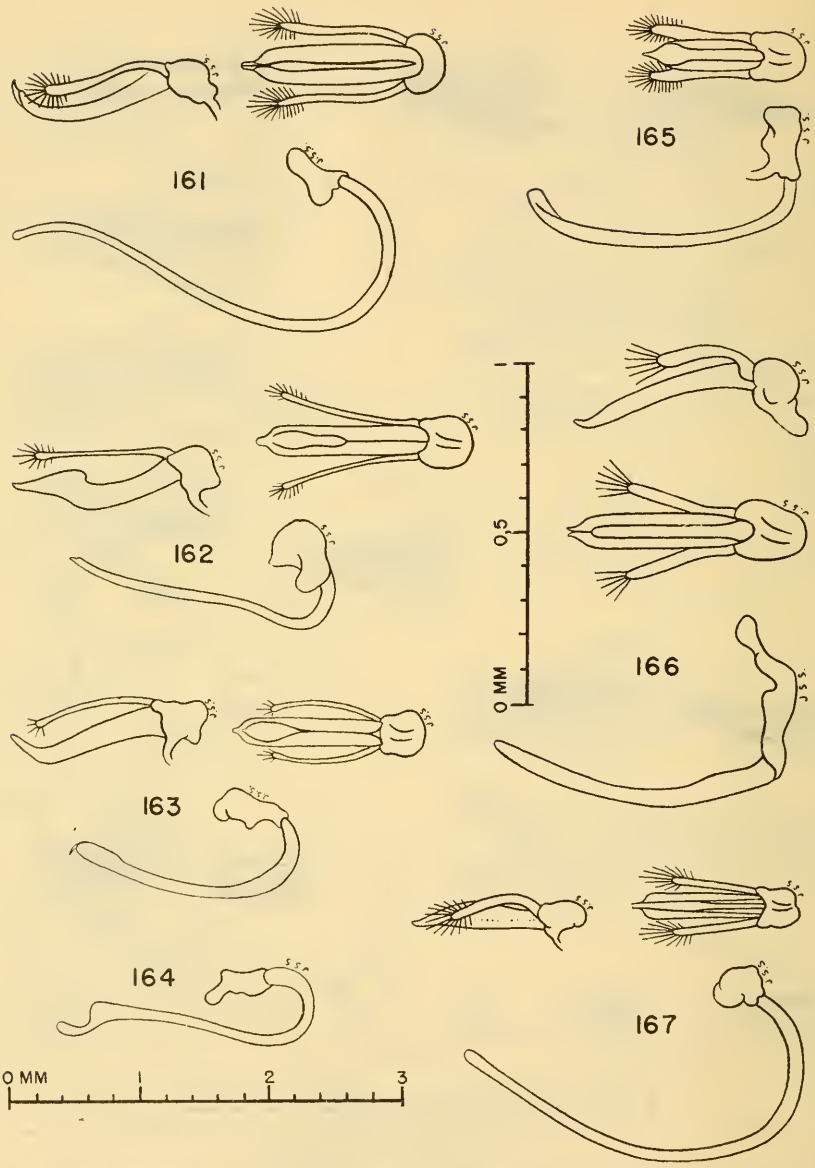
FIGS. 149-153.—Male genitalia.

149, *Epilachna argus;* 150, *Afissa admirabilis;* 151, *fallax;* 152, *insignis;* 153, *macularis.*



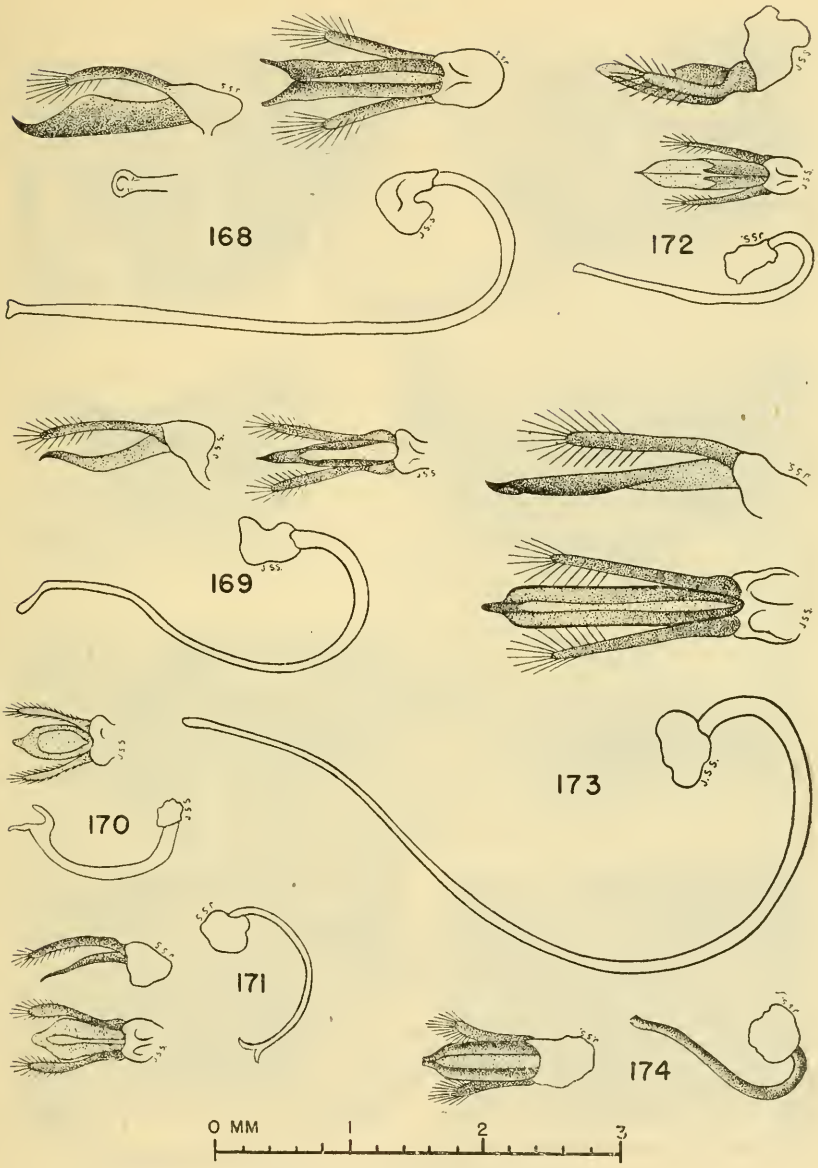
FIGS. 154-160.—Male genitalia.

154, *Afissa bengalica;* 155, *manderstjernae;* 156, *atypica;* 157, *Afidenta mimetica;* 158, *Afissa flavicollis;* 159, *quadricollis;* 160, *expansa.*



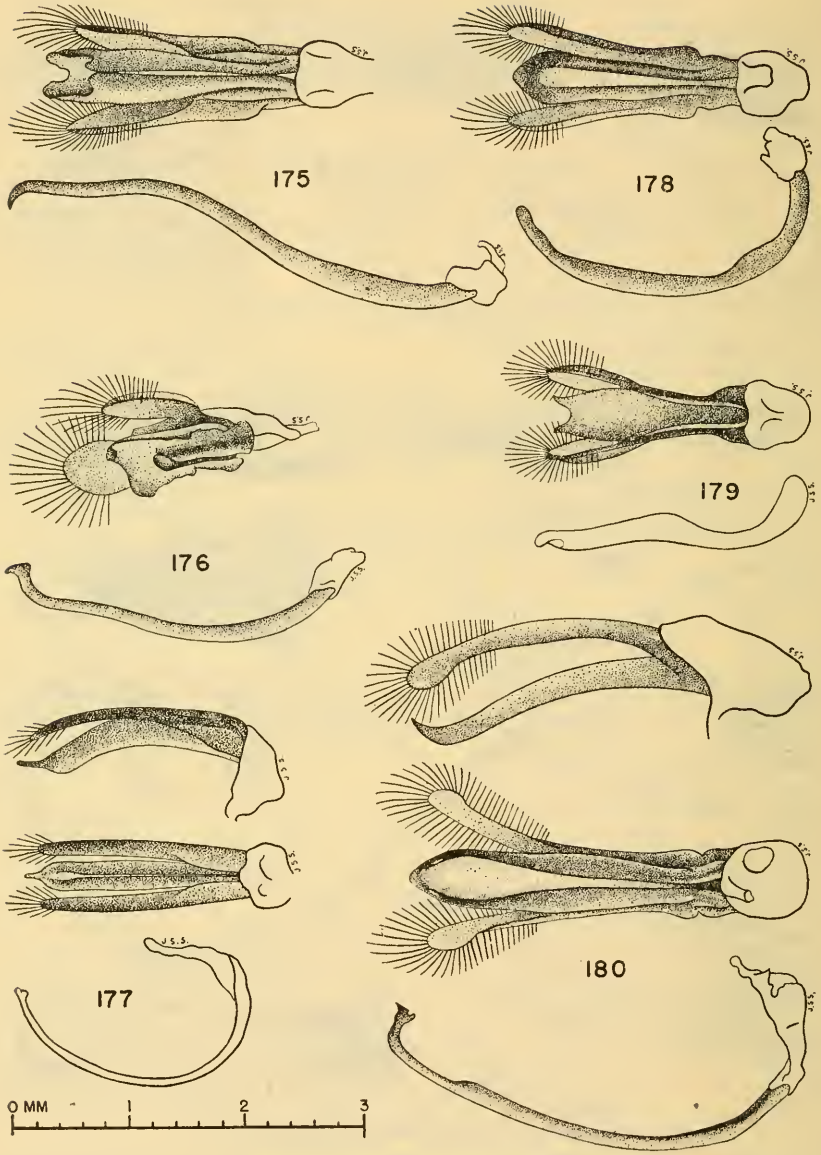
FIGS. 161-167.—Male genitalia.

161, *Afissa gedeensis;* 162, *15-guttata;* 163, *siamensis;* 164, *mysticoides;* 165, *ocellatae-maculata;* 166, *bicrescens;* 167, *10-guttata.*



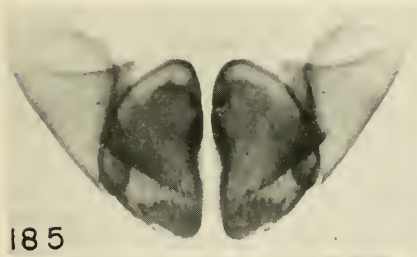
FIGS. 168-174.—Male genitalia.

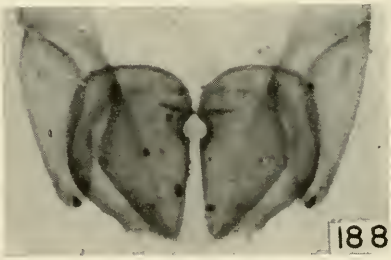
168, *Afissa coccinelloides;* 169, *mystica;* 170, *Subcoccinella 24-punctata;* 171, *Cynegetis impunctata;* 172, *Afissa elvina;* 173, *longissima;* 174, *provisoria.*



FIGS. 175-180.—Male genitalia.

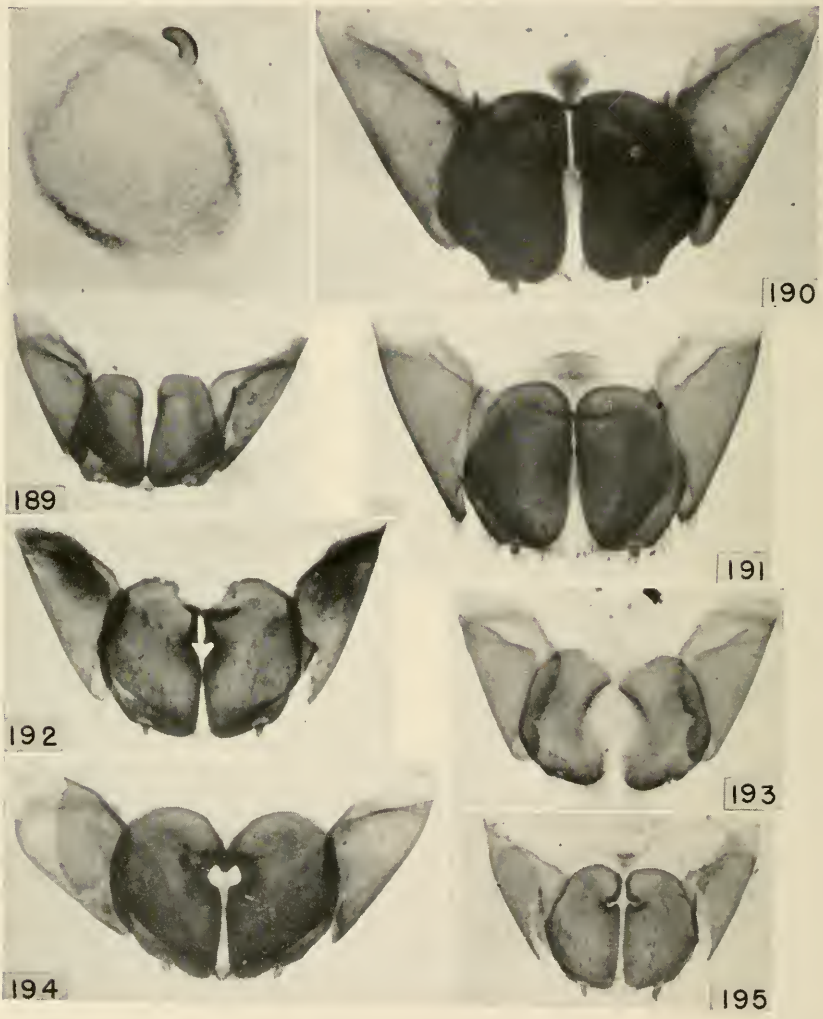
175, *Afissa convexa;* 176, *complicata;* 177, *szechuana;* 178, *chapini;* 179, *hauseri;* 180, *magna.*





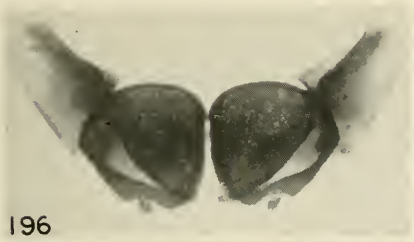
FIGS. 181-188.—Female genitalia.

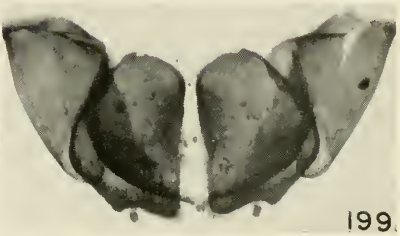
181, *Epilachna sparsa;* 182, *dentulata;* 183, *11-variolata;* 184, *signatipennis;* 185, *pytho;* 186, *pytharga;* 187, *doryca;* 188, *gangetica.*



FIGS. 189-195.—Female genitalia.

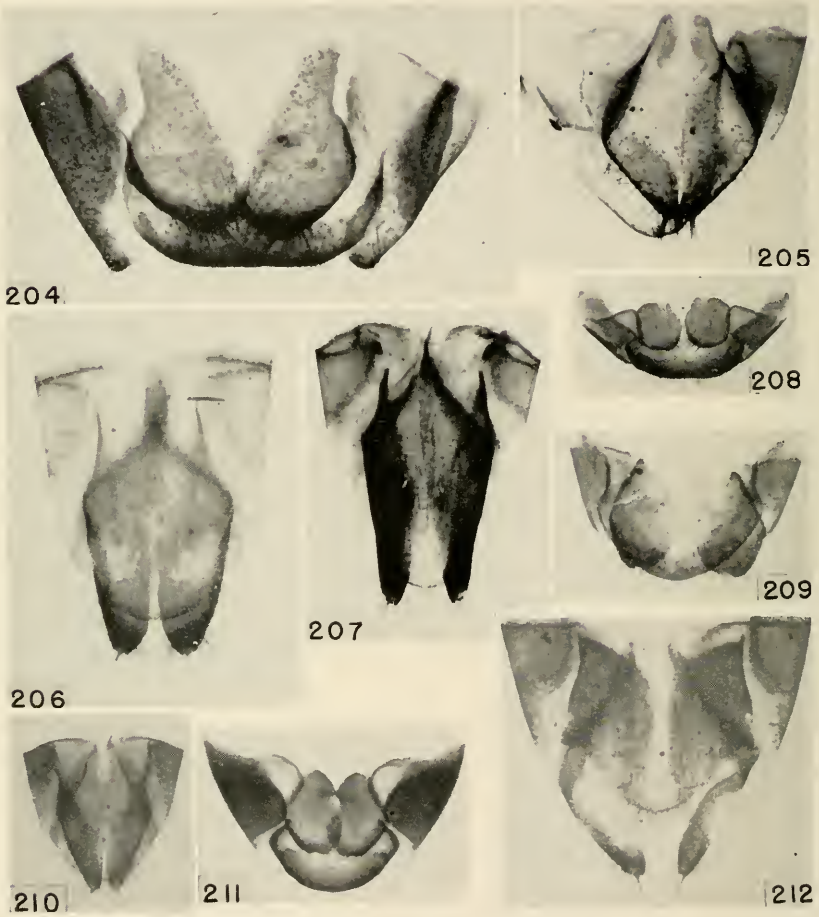
189, *Epilachna deyrollii;* 190, *weissmanni;* 191, *bakeri;* 192, *bagniana;* 193, *mindanaonis;* 194, *haemorrhoa;* 195, *emarginata.*





FIGS. 196-203.—Female genitalia.

196, *Epilachna diversa;* 197, *chrysomelina;* 198, *boisduvali;* 199, *emeasticta;* 200, *guttatopustulata,* tergite X separated from the rest; 201, *Afidenta mimetica;* 202, *Epilachna biroi,* plates only; 203, *Afissa admirabilis.*

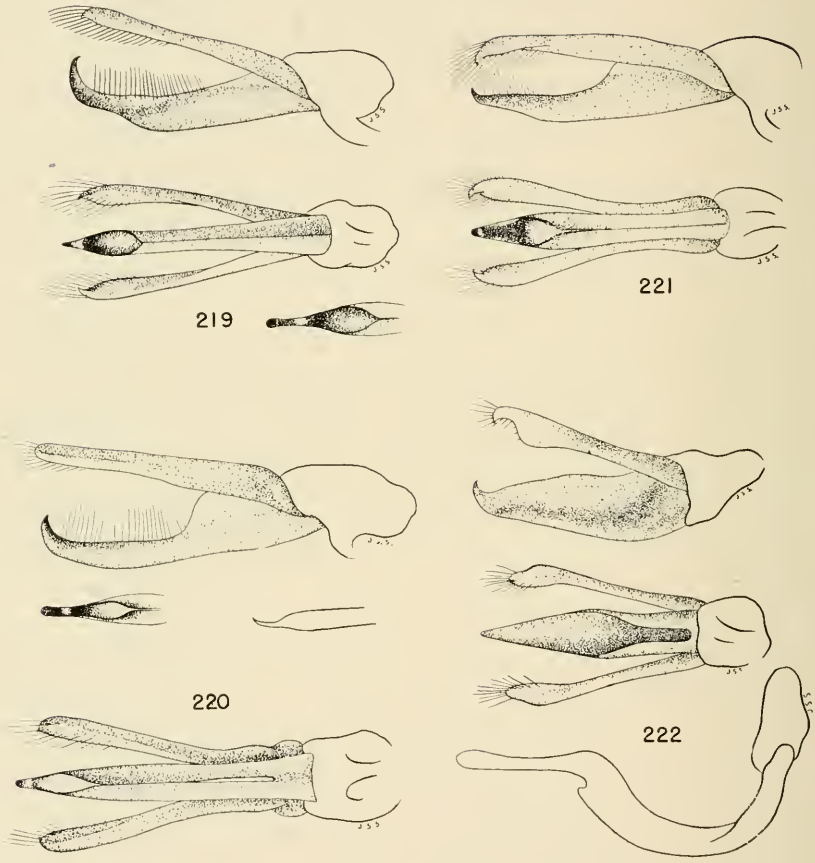


FIGS. 204-212.—Female genitalia.

204, *Afissa maxima*; 205, *fallax*; 206, *flavicollis*; 207, *longissima*; 208, *manderstjernae*; 209, *quadricollis*; 210, *bicrescens*; 211, *15-guttata*; 212, *dumerili*.

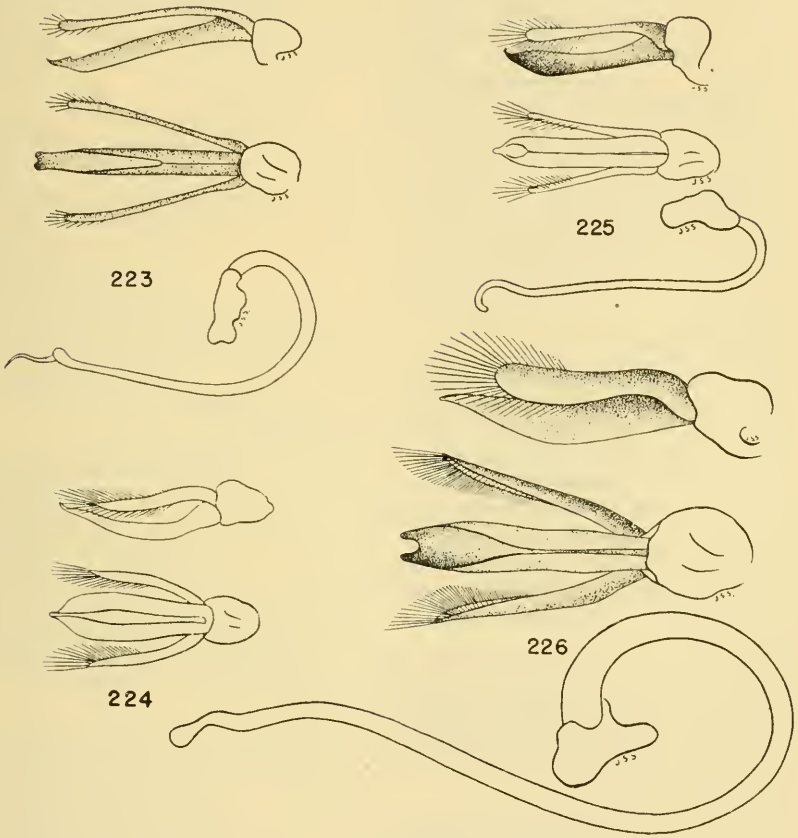
FIGS. 213-218.—Female genitalia.

213, *Ifissa convexa*; 214, *complicata*; 215, *szechuana*; 216, *subacuta*; 217, *chapini*; 218, *Epiverta chelonia*.



FIGS. 219-222.—Male genitalia.

219, *Epilachna sexta;* 220, *septima;* 221, *parafasciata;* 222, *ocellata.*



FIGS. 223-226.—Male genitalia.

223, *Afidenta bisquadripunctata*; 224, *Afissa incauta*; 225, *chinensis*; 226, *anhweiana*.