RAYMOND B. MANNING

A Review of the Genus Harpiosquilla (Crustacea, Stomatopoda), with Descriptions of Three New Species

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ABSTRACT

Manning, Raymond B. A Review of the Genus *Harpiosquilla* (Crustacea, Stomatopoda), with Descriptions of Three New Species. *Smithsonian Contributions to Zoology,* 36:1–41. 1969.—Available specimens of the large squillid *Harpiosquilla* from the collections of the Australian Museum, Sydney, and the Division of Crustacea, National Museum of Natural History, Smithsonian Institution, show that the genus comprises seven species; three of these species are newly described. The species of *Harpiosquilla* occur throughout the Indo-West Pacific region, from Japan and Australia westward to the Red Sea and South Africa; some species, particularly *H. annandalei, H. harpax,* and *H. raphidea* are widely distributed in the region whereas others, including *H. indica,* new species (India), *H. japonica,* new species (Japan), and *H. stephensoni,* new species (Australia), exhibit more limited distribution patterns. All available literature is summarized, and the descriptive accounts are accompanied by notes on biology, development, and distribution.

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Contents

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A Review of the Genus *Harpiosquilla* (Crustacea, Stomatopoda), with Descriptions of Three New Species

Introduction

Examination of two species of *Harpiosquilla* for a report on the stomatopods of Madagascar (Manning, 1968b) revealed that a single specimen of *Harpiosquilla* from Australia identified by me in 1966 as *H. harpax* was actually an undescribed species. Through the kindness of John C. Yaldwyn, formerly of the Australian Museum, I was able to examine all material of *Harpiosquilla* in the collection of that institution. The series included *H. harpax, H. melanoura,* which was described from Madagascar in 1968, and an undescribed species, named *H. stephensoni* below. Although Australian specimens of both *H. harpax* and *H. raphidea* had been recorded in the collections of the Australian Museum, the latter species apparently does not occur in Australian waters. The surprising absence of *H. raphidea,* supposedly the most widely distributed species of the genus, in Australian waters, led me to examine the series of *Harpiosquilla* in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution (SI Crust.) and the collections made by the International Indian Ocean Expedition (IIOE). Two other undescribed species were found in these collections. The present review of the species of *Harpiosquilla* results from the study of these three collections.

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Terms and measurements used herein have been explained in detail in earlier papers (Manning, 1966, 1968b).

Acknowledgments

I am indebted to John Yaldwyn for the loan of the extensive series of *Harpiosquilla* from the Australian Museum (AM) and for promoting the exchange of several specimens from that series with the Division of Crustacea, Smithsonian Institution. L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, Leiden (RMNH), made available the lectotype of *Harpiosquilla harpax,* without which the identity of several of the species recognized below would have remained in doubt. The line drawings were made by my wife Lilly with the support of the Office of Oceanography and Limnology, Smithsonian Institution. I also thank Fenner A. Chace, Jr. and David L. Pawson for their comments on the manuscript.

Systematic Account

Genus *Harpiosquilla* Holthuis, 1964

Alimerichthus Claus, 1871 p. 147 [p. 39 on separate; a junior homonym of *Alimerichthus* Guérin-Méneville, 1855].—Holthuis and Manning, 1964, pp. 138, 143.—Evans and China, 1966, p. 205 [listed] [name no. 1822 on Official Index of Rejected and Invalid Generic Names in Zoology].

Harpiosquilla Holthuis, 1964, p. 140.—Manning, 1968a, p. 121.

DIAGNOSIS.—Eye large, T-shaped, cornea bilobed and much broader than stalk; ocular scales separate; carapace usually with median, intermediate, lateral and reflected marginal carinae; median carina not bifurcate at either end; posterolateral margins of carapace with deep excavations, anterior margin of each excavation angled; mandibular palp present; 5 epipods present; dactylus of raptorial claw with teeth, outer margin of dactylus usually with prominent angled or rounded lobe in adult males; opposable margin of propodus of raptorial claw with spaced erect spines rather than closely set pectinations; lateral process of fifth thoracic somite usually an inconspicuous lobe, fifth somite usually also with ventral pair of spines; lateral processes of sixth and seventh thoracic somites not strongly bilobed, usually acute and sharp posterolaterally; abdomen broad, with 8 pairs of carinae on first 5 somites, 6 on the sixth, submedians usually low, absent in some species; telson without supplementary dorsal ornamentation other than median carina and carinae of marginal teeth; 3 pairs of marginal teeth present on telson, submedians with fixed apices, prelateral lobes present; inner spine of basal prolongation of uropod the longer, inner margin crenulate or serrate.

TYPE-SPECIES.—*Squilla harpax* de Haan, 1844, by original designation. The gender is feminine.

NUMBER OF SPECIES.—Seven, of which three are described as new herein.

RANGE.—Indo-West Pacific region, from Japan and Australia in the Pacific to the Red Sea and South Africa. Also see General Remarks (p. 36).

REMARKS.—Until 1952, only two of the species currently assigned to *Harpiosquilla, H. annandalei* and *H. raphidea,* were recognized by students of the group. In that year K. K. Tiwari and S. Biswas, studying the collections of the Zoological Survey of India, pointed out that *raphidea* comprised two species, *raphidea sensu stricto* and *harpax,* a species described from Japan by W. de Haan in 1844. They gave the diagnostic features of the two species and included a list of localities based on materials in the Zoological Survey. Another species, *H. melanoura,* was described by me in 1968(b), and three additional new species are described below. The genus now comprises seven species.

Most accounts in the literature are too brief to allow us to determine which of the seven species might have been reported by earlier workers as *Squilla raphidea.* Where possible, however, I have tried to identify records in the literature and assign them to one of the species recorded here. Sometimes the accounts give information, either in the text or in the figures, which makes this possible; in other cases I have been able to examine specimens previously recorded, as in the collections of the Australian Museum which proved to include three species, all incorrectly identified as *H. raphidea;* and in some cases, notably records of *H. raphidea* from China and Japan, corrections can be made on the basis of geography. *Harpiosquilla raphidea* does not occur in the Red Sea and is not known to occur north of the Philippine Islands in the Pacific Ocean, so records from those areas must be referable to other species. Under the accounts of both *H. harpax* and *H. raphidea* I have included a section on "Synonymy" to explain my identification of the old records. Early records which have not been verified by reexamination of the material must be accepted with caution.

Harpiosquilla includes the largest known stomatopods, the largest species being *H. raphidea* (Fabricius), which attains a total length of 335 mm. Their large size and the deep posterolateral excavations on the margins of the carapace make adult members of the genus very easy to recognize. Another characteristic of species of *Harpiosquilla* is the row of spaced, erect spines on the opposable margin of the propodus of the claw. These spines apparently replace the closely set pectinations found on the propodus of all other members of the family Squillidae. Similar spines are also found on the propodus of the two species of *Bathysquilla,* the only genus in the Bathysquillidae. *Bathysquilla* and *Harpiosquilla,* however, were derived from separate stocks and apparently have developed the remarkable armature of the claw independently. The function of the spines on the propodus is unknown; they may aid in holding prey. Their number and arrangement may have some value as a specific character for *H. raphidea,* for in that species, as pointed out by Tirmizi and Manning (1968), there is usually no more than one smaller spinule or denticle between the major erect spines. In the other species there are usually several smaller spinules and denticles between the major spines.

Adults of *Harpiosquilla* show no apparent close relationship to any other genus in the family Squillidae; the genus occupies an isolated position in the family. On the basis of his studies on the larval development of stomatopods, K. H. Alikunhi (1952, p. 313) made

the following observations: "The larvae of *S.[quilla] raphidea* occupy a peculiar position. Though described as belonging to the *Alimerichthus* group, they show some conspicuous differences from the typical *Alimerichthus* of the *'Chloridella'* group, *viz.;* larger size; broad shield-like carapace and absence of free teeth other than the terminal on the dactylus. In the number of marginal spinules on the carapace (4+3) these larvae perhaps occupy an intermediate position between *Alimerichthii* of the *'Chloridella'* and *Scorpio* groups on the one hand and the typical *Alima* larvae on the other." Since that was written, each of these groups referred to above have been recognized as distinct genera. Thus *Harpiosquilla,* on the basis of larvae, may occupy a position intermediate between (a) *Clorida* and *Cloridopsis,* and other small-eyed genera, and (b) *Oratosquilla* and its allies. Its precise relationship to any of these genera cannot be determined with available information.

There is no fossil record of the genus.

That *H. harpax* is generically distinct from *Squilla* was recognized perhaps as long as 100 years ago by the zoologist William Stimpson; he used the generic name *Prolepta* on the label of the specimen collected by the North Pacific Exploring Expedition. As far as I can determine, that name has not been published.

Inasmuch as we know relatively little about the biology of stomatopods in general, we are fortunate in having some basic information available on the early ontogeny and postlarval development of *Harpiosquilla,* primarily as a result of the work of K. H. Alikunhi and K. B. Nair in India. Possibly this is due to the easily recognizable facies of *Harpiosquilla* adults. It is ironic that we cannot determine with certainty which of the species of *Harpiosquilla* they studied. Nair (1941) reported on extrusion of eggs and embryological development in a *Harpiosquilla* from Madras, and Alikunhi, in a long series of studies on larvae culminating in his extensive work on postlarval development of stomatopods published in 1967, examined material from Madras and other localities. Both *H. harpax* and *H. raphidea* could occur there, so I have here referred their papers to whichever name was used in their works.

The characteristic larvae of *Harpiosquilla,* first reported by Claus (1871) as *Alimerichthus,* are discussed in some detail by Alikunhi (1952, 1959). They are easily recognized by the broad carapace with one or two strong, laterally directed lateral spines. Alikunhi (1967) has also given a very detailed account of growth changes in the postlarvae. He was able to hold one specimen in the laboratory for 282 days; the specimen underwent 14 molts.

All of the descriptions given here are based on subadults or adults. I have seen no very young specimens of any species and can only predict some possible differences in major morphological features between juveniles and adults; Alikunhi (1967) has noted some characteristics of juveniles. The eyes of juveniles are undoubtedly larger than those of adults; within the size range of the specimens examined the corneal indices of smaller specimens are always smaller than those of larger specimens (Table 1); this is the normal pattern found also in other squillids. The body carinae of young specimens are not so well developed as in adults; this could cause a problem in recognizing small specimens of *H. harpax,* for example, in which the submedian carinae of the abdomen of adults are at best low and poorly developed. In *H. stephensoni,* new species, the lateral process of the fifth thoracic somite of the smallest specimens examined is not as markedly angled nor does it project as far laterally as in the largest specimens; thus the lateral spine on that somite, characteristic of both *H. annandalei* and *H. raphidea,* may be but a blunt lobe in juveniles.

Alikunhi (1967, p. 903) made the following observations on postlarvae and early juveniles of *Harpiosquilla*:

> . . . the early post-larva is characterised by the absence of antero-lateral spines on the carapace and the presence of terminally articulated submedian spines on the telson. Though rudimentary spines appear on the antero-lateral corners of the carapace during the second or third post-larval stage, the terminal articulation of the submedian spines of the telson continues to be present even after the ninth post-larval moult. In the species of the *nepa* group the terminal articulation of the submedian spines disappears with the first post-larval moult; *i.e.,* it is present only during the first post-larval stage. In this feature also *H. raphidea* differs from *S. nepa* or *S. woodmasoni* but resembles *S. latreillei* (*Chloridella* group).

Adults are easily recognized by the presence of an inflated median carina on the telson; often the submedian carinae of the sixth abdominal somite are also inflated in adults of both sexes. Adult males of most species may be distinguished by the presence of a prominent angled or rounded projecting lobe on the outer margin of the dactylus of the raptorial claw; the bases of some of the teeth of the claw may also be enlarged. The chelae and telsons of both sexes have been figured where possible.

The color pattern of preserved specimens is a good specific character, particularly the coloration of the uropod. In *H. melanoura* the distal segment of the uropodal exopod is entirely black. In *H. annandalei* the same segment is black with a white midrib and this species also has distinctive paired submedian spots on the telson. In *H. harpax, H. indica,* new species and *H. stephensoni,* new species, only the inner half of the distal segment of the uropodal exopod is dark, but there are other less distinctive differences in color pattern. I have not been able to determine with certainty the color pattern of the uropod in either *H. japonica,* new species, or *H. raphidea.*

The armature of the abdominal carinae appears to be a very good specific character. In *H. annandalei,* for example, the submedian carinae of both the fifth and sixth abdominal somites are armed posteriorly; in all other species only the submedians of the sixth somite are provided with spines. Similarly, in *H. raphidea* and *H. annandalei* the intermediate carinae of all six abdominal somites are spined posteriorly, but in *H. indica* and *H. japonica,* the intermediate carinae of the first and second somites are unarmed and different patterns of abdominal armature are present in the other three species. In general, the number of armed carinae increases with age.

The relative distinctness of the submedian carinae of the last three thoracic and first five abdominal somites also may be of help in the recognition of species. In *H. raphidea* these carinae are strongly developed, more so than in any of the other species. The submedian carinae of the body in both *H. japonica* and *H. stephensoni* are not so well developed, being lower and less well defined, but they are still readily distinguishable. In *H. harpax* the submedian carinae are very low, poorly defined, and often can be detected only when the dorsal surface is dried. The submedian carinae are completely absent in both *H. indica* and *H. melanoura;* the latter species is also the only one which lacks a median carina on the carapace.

The marginal denticles of the telson are sharper and better defined in *H. annandalei, H. harpax, H. indica,* new species, and *H. melanoura* than in the remainder of the species.

The eyes of each species are of different sizes and these differences are reflected in the corneal indices, summarized for all species in Table 1. Because of the change in the index with size I have separated the indices in the table by arbitrary subgroups based on carapace length. The overall range given at the bottom

TABLE 1.—*Corneal Indices of species of* Harpiosquilla

Carapace length in (mm)	*H. annandalei*			*H. raphidea*		
	Range	No.	Mean	Range	No.	Mean
11–15	–	1	262	–	–	–
16–20	280–291	3	285	–	–	–
21–25	260–287	6	278	–	–	–
26–30	–	–	–	–	–	–
31–35	–	–	–	–	–	–
36–40	–	–	–	–	–	–
41–45	–	–	–	–	1	410
46–50	–	–	–	–	1	486
51–55	–	–	–	–	1	469
56–60	–	–	–	475–504	3	489
Overall range	240–291	–	–	380–530	–	–

Carapace length in (mm)	*H. japonica*			*H. stephensoni*		
	Range	No.	Mean	Range	No.	Mean
11–15	–	–	–	–	–	–
16–20	–	–	–	–	–	–
21–25	–	–	–	–	–	–
26–30	–	1	328	–	–	–
31–35	325–337	2	331	–	1	336
36–40	–	–	–	349–392	3	364
41–45	–	–	–	–	1	366
46–50	–	–	–	396–420	2	408
51–55	–	–	–	–	1	434
56–60	–	–	–	410–425	2	418
Overall range	325–337	–	–	336–434	–	–

Carapace length in (mm)	*H. melanoura*			*H. harpax*			*H. indica*
	Range	No.	Mean	Range	No.	Mean	
11–15	–	–	–	251–292	9	275	–
16–20	–	1	229	263–301	4	283	–
21–25	237–246	3	240	269–311	10	290	–
26–30	–	1	252	269–320	18	306	–
31–35	–	1	271	305–358	16	327	290
36–40	–	–	–	294–344	5	323	–
41–45	–	–	–	–	1	329	–
46–50	–	–	–	–	1	356	–
51–55	–	–	–	–	–	–	–
56–60	–	–	–	–	–	–	–
Overall range	229–271	–	–	251–388	–	–	290

of each column includes records of eye size given in the literature.

One feature of telson morphology is helpful in species recognition, particularly when more than one species is present in a sample. The carinae of the marginal teeth are dorsally tuberculate or nodulose in all species, and the known species show a wide range of size and prominence of this feature. In *H. raphidea* the tubercles are large, inflated, and few in number; the opposite extreme can be seen in *H. harpax* and *H. melanoura* in which the tubercles are small, often sharp, and very numerous. *Harpiosquilla annandalei, H. indica,* new species, *H. japonica,* new species, and *H. stephensoni,* new species, fall between these two extremes; in *H. annandalei* the tubercles are large, low, and sparse. Specimens of *H. stephensoni,* new species, and *H. harpax* (or any of those with very fine tuberculation) can always be separated on the basis of the tuberculation of the marginal carinae. This feature is shown in the plates in which the telsons of each species have been illustrated. The species, if placed in a series based on the number of tubercles, would be arranged as follows: *H. raphidea* (few tubercles), *H. annandalei, H. japonica, H. stephensoni, H. indica, H. harpax,* and *H. melanoura* (many tubercles). The marginal carinae of the telson are sharpest in *H. annandalei, H. harpax,* and *H. melanoura.*

Another feature which has not been used previously as a specific character is the relative length of the lateral and marginal carinae of the telson. In adults of *H. raphidea* both carinae are inflated and may fuse completely. In the remainder of the species they are sharper and distinct throughout their length. The marginal carina of *H. melanoura* is almost three times as long as the lateral carina; in *H. harpax* it is more than twice but less than three times as long as the lateral carina, and in the remainder of the species it is less than twice as long. It seems to be shortest in *H. indica,* for in the only known specimen of that species the marginal carina is no more than one and one-half times as long as the lateral carina. The species with the longest marginal carinae, *H. harpax* and *H. melanoura,* can be distinguished from all other species on the basis of this character.

The ventral keel of the eighth thoracic somite seems to have limited value as a specific character; it is sharp in *annandalei,* rounded in the remainder of the species.

Two of the species, *H. annandalei* and *H. raphidea,* differ from the other five in having the intermediate carinae of the thoracic somites armed posteriorly; the remaining species in the genus have unarmed intermediate carinae on the thoracic somites.

The species seem to fall into two natural groups based on the shape of the rostral plate. In *H. harpax, H. indica,* new species, *H. melanoura,* and *H. raphidea* the rostral plate is elongate, anteriorly tapering to a slender median projection. In *H. annandalei, H. japonica,* new species, and *H. stephensoni* new species, the plate is short, with the length and width subequal or the width greater, and the apex is rounded or obtusely angled, lacking a noticeable median projection.

The key to species is based on adults.

Key to Species of *Harpiosquilla*

1. Submedian carinae distinct on posterior 3 thoracic and first 5 abdominal somites. (Carapace with median carina.).....2

1′. Submedian carinae indistinct or lacking on posterior 3 thoracic and first 5 abdominal somites. (Rostral plate longer than broad, with apical projection; raptorial dactylus of male with prominent angular projection on outer margin; fifth thoracic somite laterally acute; ventral keel of eighth thoracic somite rounded; intermediate carinae of thoracic somites unarmed posteriorly; submedian carinae of fifth abdominal somite unarmed posteriorly.).5

2(1). Intermediate carinae of thoracic somites and first abdominal somite spinous posteriorly. (Raptorial dactylus with 8 teeth; fifth thoracic somite laterally acute; intermediate carinae of second abdominal somite spinous posteriorly.).....3

2′. Intermediate carinae of thoracic somites and first abdominal somite unarmed posteriorly. (Rostral plate as broad as long, without apical projection; ventral keel of eighth thoracic somite rounded; submedian carinae of fifth abdominal somite unarmed posteriorly; marginal carina of telson less than twice as long as lateral carina.).....4

3(2). Rostral plate as broad as long, without apical projection; raptorial dactylus of adult male without angular projection on outer margin; ventral keel of eighth thoracic somite sharp; submedian carinae of fifth abdominal somite spinous posteriorly; size moderate, total length less than 150 mm. (Marginal carina of telson less than twice as long as lateral carina; distal segment of uropodal exopod black with white midrib.).....1. ***H. annandalei***

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3′. Rostral plate longer than broad, with long apical projection; raptorial dactylus of adult male with prominent angular projection on outer margin; ventral keel of eighth thoracic somite rounded; submedian carinae of fifth abdominal somite unarmed posteriorly; size large, total length up to 335 mm.....2. ***H. raphidea***

4(2′). Raptorial dactylus with 8 teeth; intermediate carinae of second abdominal somite unarmed posteriorly; size moderate, total length less than 175 mm. (Fifth thoracic somite rounded laterally.).....3. ***H. japonica,*** new species

4′. Raptorial dactylus with 7 teeth; intermediate carinae of second abdominal somite spinous posteriorly; size large, total length up to 315 mm. (Raptorial dactylus of adult male with prominent angular projection on outer margin; distal segment of uropodal exopod dark colored on inner half.).....4. ***H. stephensoni,*** new species

5(1′). Carapace without median carina; distal segment of uropodal exopod entirely black. (Raptorial dactylus with 8 teeth; no submedian carinae on thoracic and first 5 abdominal somites; intermediate carinae of first abdominal somite unarmed posteriorly; marginal carina of telson more than twice as long as lateral carina; size moderate, total length less than 170 mm.).....5. ***H. melanoura***

5′. Carapace with median carina; distal segment of uropodal exopod dark colored on inner half only.....6

6(5′). Raptorial dactylus with 8 teeth; indistinct submedian carinae on thoracic and first 5 abdominal somites; intermediate carinae on second abdominal somite spinous posteriorly; marginal carina of telson more than twice as long as lateral carina; size moderate to large, total length up to 248 mm.....6. ***H. harpax***

6′. Raptorial dactylus with 9 teeth; no submedian carinae on thoracic and first 5 abdominal somites; intermediate carinae on second abdominal somite unarmed posteriorly; marginal carina of telson less than twice as long as lateral carina; size moderate, total length of mature individuals 150 mm or more.....7. ***H. indica,*** new species

1. *Harpiosquilla annandalei* (Kemp, 1911)

FIGURES 1–3

Squilla annandalei Kemp, 1911, p. 99; 1913, p. 92, pl. 7 (figs. 78–80).—Sunier, 1918, p. 71.—Kemp and Chopra, 1921, pp. 298 [listed], 307.—Chopra, 1934, p. 27, fig. 2; 1939, p. 159, fig. 7.—Foxon, 1939, p. 259 [discussion of larva].—Serène, 1954, pp. 6, 8 [listed].—Stephenson and McNeill, 1955, p. 255 [key].—Holthuis, 1964, p. 140 [listed].—Manning, 1968a, p. 121 [listed].

Squilla annendalei.—Alikunhi, 1952, pp. 267, 269 [discussion of larvae; erroneous spelling].

Harpiosquilla annandalei.—Manning, 1965, p. 250, pl. 11a.—Lee and Wu, 1966, p. 51, figs. 6A–B.—Manning, 1968b, p. 14 [key].—Tirmizi and Manning, 1968, p. 31 [discussion].

MATERIAL.—1 ♂, 71 mm; Tung Kang, Taiwan; 74–93 m; S. Lee, S. K. Wu; 5 March 1965; SI Crust. 113649.—1 ♂, 107 mm; 2 ♀, 109–117 mm; Andaman Sea, Mergui Archipelago; 09°13′N, 97°51′E; 58–60 m; ANTON BRUUN Cruise 1, Sta. 20; IIOE; 23 March 1963; SI Crust. 125350.—3 ♀, 72–93 mm; Bay of Bengal, off Burma; 19°32′N, 92°52′E; 53 m; ANTON BRUUN Cruise 1, Sta. 49; IIOE; 6 April 1963; SI Crust. 125348.—1 ♀, 99 mm; Gulf of Oman, off Iran; 25°45–50′N, 57°07′E; 92–95 m; clay, mud, sand, minute gastropod shells; ANTON BRUUN Cruise 4B, Sta. 255A; IIOE; 30 November 1963; SI Crust. 125349.—1 ♀, 97 mm; Gulf of Oman, off Iran; 26°10–13′N, 57°02′E; 55–64 m; green mud; ANTON BRUUN Cruise 4B, Sta. 256A; IIOE; 30 November 1963; AM.—2 ♂, 129–135 mm; Gulf of Oman, off Arabia; 25°12′N, 56°47–51′E; 206 m; grey soft mud; ANTON BRUUN Cruise 4B, Sta. 263A; IIOE; 2 December 1963; SI Crust. 125716.

DIAGNOSIS.—Size moderate, adults with TL less than 150 mm; antennular peduncle longer than carapace and rostral plate combined; corneal indices ranging between 240 and 291 (Table 1); rostral plate (Figure 2) with length and width subequal or width greater, apex rounded or obtusely angled, lacking slender anterior projection; carapace with median carina; opposable margin of propodus of claw with smaller spines and denticles between largest spines; dactylus of claw with 8 teeth, outer margin of dactylus lacking prominent angular projection in adult males; fifth thoracic somite (Figure 3) acutely angled or spined laterally; posterior 3 thoracic somites with submedian and intermediate carinae, intermediates with posterior spines; ventral keel of eighth thoracic

somite sharp; all six abdominal somites with submedian carinae, abdominal carinae spined as follows: submedian 5–6, intermediate 1–6, lateral 1–6, marginal 1–5; denticles 5–7, 10–11, 1, inner submedians largest, rounded, remainder spiniform; marginal carina less than twice as long as carina of lateral tooth; postanal carina short, not extending halfway between anus and posterior margin; distal segment of uropodal exopod black with white midrib.

COLOR.—Second and third segments of antennular peduncle with proximal dorsal black spot and distal black ring, proximal spot fainter on third segment; dark transverse bar present dorsally between ophthalmic and antennular somites; medan portion of rostral plate outlined in dark pigment; carapace with anterolateral margins, posterior median margin, grooves, and carinae outlined with dark pigment; merus of claw with inner subdistal black spot and with proximal and distal dark spot on dorsal depression; posterior 3 thoracic and all 6 abdominal somites with dark posterior line; submedian and intermediate carinae of carapace darker than adjacent surface; second abdominal somite with transverse dark bar middorsally; first and third to fifth abdominal somites each with traces of broken transverse bar; telson with pair of proximal, submedian dark circles, margin darker than center; pits, arranged in concentric rows on dorsum of telson, dark; distal segment of uropodal exopod black with white midrib; distal half of uropodal endopod with diffuse dark pigment. The overall color pattern is shown on Figure 1.

SIZE.—Males, TL 71–135 mm; females, TL 72–117 mm. Males of TL 106–123 mm and females of TL 43–115 mm have been recorded in the literature.

Other measurements of a male, TL 107 mm: carapace length 22.1; cornea width 8.5; antennular peduncle length 26.5; rostral plate length 2.7, width 3.3; raptorial propodus length 27.9; fifth abdominal somite width 20.0; telson length 17.8, width 16.8.

DISCUSSION.—*Harpiosquilla annandalei* can be distinguished readily from all other species in the genus by a variety of characters, including the length of the antennular peduncle (longer than the carapace and rostral plate combined), the sharp ventral keel on the eighth thoracic somite, the armed submedian carinae of the fifth abdominal somite, and the color pattern of the telson and uropod (Figure 1). None of these features is found in any other species of *Harpiosquilla* now known.

FIGURE 1.—*Harpiosquilla annandalei* (Kemp). Male, TL 135 mm, Gulf of Oman: dorsal view.

Harpiosquilla stephensoni, new species, and *H. japonica,* new species, also have a short rostral plate but in neither of those species are the intermediate carinae of the thorax or the submedian carinae of the fifth abdominal somite armed posteriorly. *Harpiosquilla stephensoni,* new species, and *H. raphidea* also have an acute or even spiniform lateral process on the fifth thoracic somite; *H. raphidea* is the only other species of the genus in which the intermediate carinae of the last three thoracic somites are armed posteriorly and in which all intermediate carinae of the abdomen also are spined.

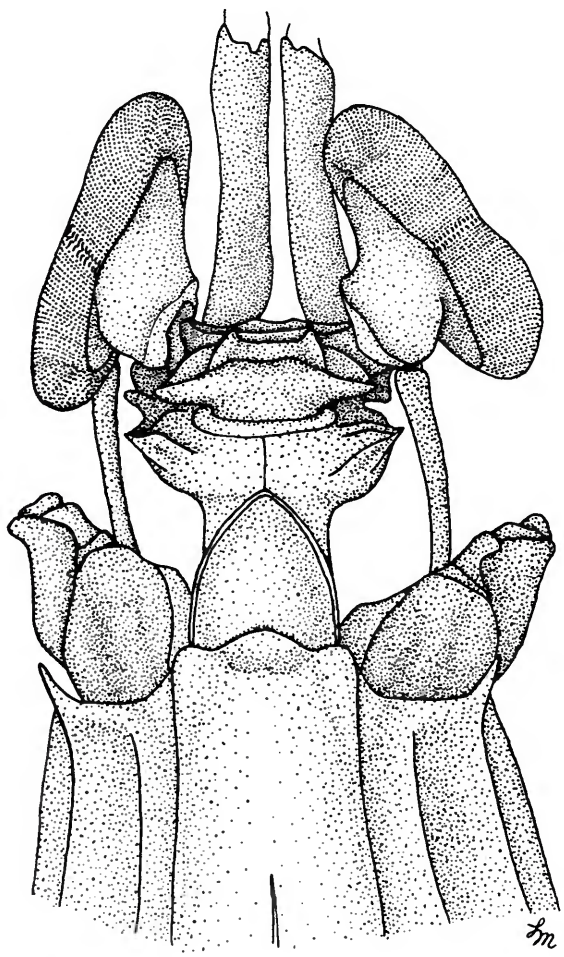

FIGURE 2.—*Harpiosquilla annandalei* (Kemp). Male, TL 135 mm, Gulf of Oman: anterior portion of carapace.

Corneal indices of *H. annandalei* are summarized in Table 1. The eyes of the specimens reported herein are similar to those of *H. harpax* of comparable size, but the overall range of corneal indices, 240–291, in contrast to that observed in *H. harpax,* 251–358, suggests that the eyes of *H. annandalei* are larger than those of *H. harpax.*

Chopra (1934, 1939) has pointed out that the anterior lobes of the lateral processes of the sixth and seventh thoracic somites are variable in shape and in some specimens may be subdivided secondarily. Similar variation in the shape of the anterior lobes of these somites is evident in the specimens reported herein. The lateral processes in *H. annandalei* (Figure 3) are more strongly bilobed than in any other species of the genus.

Harpiosquilla annandalei also has a higher and sharper median carina on the telson than any other species of *Harpiosquilla;* Lee and Wu (1966) commented on the shape of the carina in their specimens from Taiwan, and they noted that the carina, in lateral view, is convex anteriorly, concave posteriorly. The relative thinness of the median carina does not seem to be affected by age, and the median carina is not particularly inflated in either large males or large females.

One specimen, from ANTON BRUUN Sta. 49, a female TL 72 mm, had nine teeth on the dactylus of one claw, the normal complement of eight teeth on the other dactylus.

In all specimens examined the intermediate carinae of the last three thoracic somites and of all six abdominal somites were armed posteriorly.

SEXUAL DIMORPHISM.—This species does not exhibit secondary sexual dimorphism to the extent found in other species such as *H. harpax* and *H. raphidea.* The two males reported herein from ANTON BRUUN Sta. 263A are the largest recorded for the species and they show no marked sexual dimorphism. The outer edge of the dactylus of the claw in the largest male, TL 135 mm, is faintly sinuous but not markedly different in shape from the claw of the females. The teeth on the raptorial claw of these two males are slightly more inflated basally than in smaller males or in any females, but the difference in shape is relatively minor.

BIOLOGY.—Virtually nothing is known about the biology of this species. In general, it occurs in deeper water, 15–206 meters, than either *H. harpax* or *H. raphidea.* Specimens collected from the ANTON BRUUN were taken on mud or grey mud and sand. Serène

(1954) recorded the species from sandy mud, in 15–25 meters, in the Baie de Cauda, Viet-Nam. The specimen reported by Chopra (1939) was taken on green mud in 201 meters in the Gulf of Oman. *Harpiosquilla annandalei* was taken together with *H. melanoura* at ANTON BRUUN Sta. 20, in 58–60 meters off the Mergui Archipelago and with *H. harpax* at ANTON BRUUN Sta. 256A, in 55–64 meters in the Gulf of Oman.

DEVELOPMENT.—Larval stages of *H. annandalei* have not been identified with certainty. Foxon (1939) identified larvae from the Red Sea, Arabian Sea, and Gulf of Oman with *Alima multispinus* (Claus) She noted that the larvae could be separated into two groups, referred to by her as typical and atypical, and suggested that they might be the larvae of *H. raphidea* and *H. annandalei* (note that neither of these species is known to occur in the Red Sea proper and *H. raphidea* is not known with certainty to occur in the Gulf of Oman.)

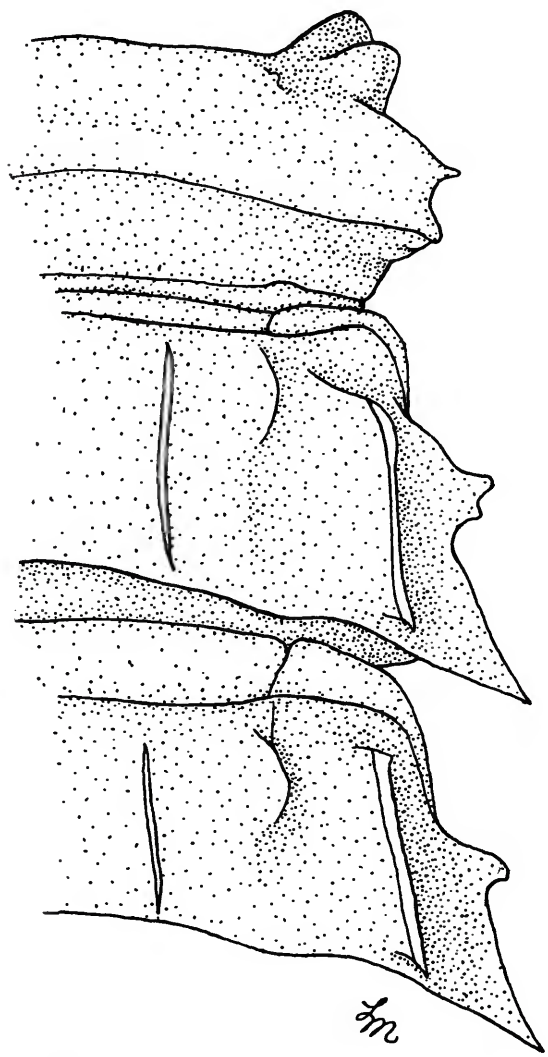

FIGURE 3.—*Harpiosquilla annandalei* (Kemp). Male, TL 135 mm, Gulf of Oman: lateral processes, of fifth, sixth, and seventh thoracic somites.

Alikunhi (1952, p. 269) pointed out that "while the atypical form is perhaps identical with *S. (Alima) raphidea,* the typical larva might well belong to the very closely related *S. annendalei* [sic]." Ingle and Della Croce (1967) corroborate Alikunhi's identification of Foxon's atypical larvae with *H. raphidea.* This seems highly unlikely if the atypical larvae came from the Red Sea rather than the Arabian Sea; however, the larvae identified with *H. raphidea* by Alikunhi could be the larvae of *H. harpax,* and this might explain the presence of this larval form in the Red Sea.

TYPE.—The four syntypes are in the Zoological Survey of India [Indian Museum], Calcutta.

TYPE-LOCALITY.—Gulf of Martaban, Burma, in 53–67 fathoms.

DISTRIBUTION.—Indo-West Pacific region, from scattered localities between Japan and the Gulf of Oman in depths between 15 and 206 meters. Records for adults in the literature are as follows: JAPAN: Hayama, Sagami Bay (Manning, 1965). TAIWAN: Tungkang market, 40–50 fms (Lee and Wu, 1966). VIET-NAM: Baie de Cauda, 15–25 m (Serène, 1954). JAVA SEA: 30–35 fms (Sunier, 1918). BAY OF BENGAL: off Kabusa Island, Mergui Archipelago, 33 fms (Kemp and Chopra, 1921); Gulf of Martaban, Burma, 53–67 fms (Kemp, 1911, 1913); Sandheads, mouth of Hughli River [Hooghly], India, less than 20 fms (Chopra, 1934). ARABIAN SEA: Gulf of Oman, 201 m (Chopra, 1939). Some of the larvae reported from the Red Sea, Arabian Sea, and Gulf of Oman by Foxon (1939) may be referable to this species.

2. *Harpiosquilla raphidea* (Fabricius, 1798)

FIGURES 4–9

Squilla raphidea Fabricius, 1798, p. 416.—Latreille, 1802, p. 279; 1828, p. 471.—Milne-Edwards, 1837, p. 524.—Gibbes, 1850, p. 199 [discussion; p. 35 on separate].—Miers, 1880, p. 27 [part].—Preudhomme de Borre, 1882, p. cxi.—de Man, 1888, p. 296.—Thallwitz, 1892, p. 55.—Hender-

son, 1893, p. 453.—Sharp, 1893, p. 108.—Thurston, 1895, p. 120.—de Man, 1898, p. 694.—Lanchester, 1900, p. 264; 1901, p. 553.—Nobili, 1903, p. 38.—Lanchester, 1906, p. 133.—Kemp, 1913, p. 88 [part]; 1915, p. 172; 1918, p. 297.—Sunier, 1918, p. 70, fig. 3.—Hansen, 1921, p. 79.—Kemp and Chopra, 1921, p. 298 [listed].—Smedley, 1927, p. 231.—Roxas and Estampador, 1930, p. 101.—Chopra, 1934, p. 27 [part].—Tweedie, 1934, p. 40.—Foxon, 1939, p. 259 [discussion of larvae].—Gravely, 1941, p. 74.—Holthuis, 1941, p. 256 [part].—Nair, 1941, p. 544, figs. 3–10, 21, 23–30, pl. 29 (figs. 34–35), pl. 30 (figs. 37–38, 40) [embryology].—Chacko, 1942, p. 404.— Alikunhi and Aiyar, 1942, p. 56, figs. 3–4 [larvae]; 1943, p. 81 [growth].—Alikunhi, 1950, p. 103 [discussion; larvae]; 1952, p. 265, fig. 9 [larvae].—Tiwari and Biswas, 1952, p. 356, figs. 3a, c, e.—Ingle, 1963, p. 14 [key].—Zimsen, 1964, p. 653 [listed].—Holthuis, 1964, p. 140 [listed].—Alikunhi, 1965, p. 35 [postlarva; listed].—Manning 1968a, p. 121 [listed].

Squilla raphidia.—Bosc, 1801–1802, p. 122 [erroneous spelling].

Squilla mantis (B) var. *major* Lamarck, 1818, p. 187 [in synonymy].—Deshayés and Milne-Edwards, 1838, p. 322; 1839, p. 373 [in synonymy].

Squilla Mantis.—Latreille, 1818, p. 6, pl. 324 [not *Squilla mantis* (Linnaeus)].

Squilla Raphidia.—Bosc, 1830, p. 95 [erroneous spelling].

Squilla Raphidea.—Herklots, 1861, p. 152 [p. 39 on separate; listed].

Alimerichthus Claus, 1871, p. 147, pl. 8 (fig. 30) [larva; p. 39 on separate].—?Brooks, 1886, p. 96 [discussion].

Alimerichthus pyramidalis Lanchester, 1903, p. 457 [larva].—Gurney, 1946, p. 161 [references].

Squilla raphidea var. *africana* Balss, 1910, p. 8, fig. 2b.

Alima pyramidalis.—Gurney, 1946, p. 159 [references].

Squilla (Alima) raphidea.—Alikunhi, 1952, p.269 [discussion of larvae].

?*Harpiosquilla raphidea.*—Alikunhi, 1967, p. 894, figs. 114–125, pl. 2 [larvae and young; part?].

Harpiosquilla raphidea.—Chhapgar and Sane, 1968, p. 45 [key.]—Manning, 1968b, p. 14 [key].—Tirmizi and Manning, 1968, p. 31, fig. 12.

not *Squilla raphidea.*—Berthold, 1845, p. 47; 1847, p. 29.—White, 1847, p. 84.—Bigelow, 1894, pp. 511 [key], 535.—Tattersall, 1906, p. 166.—Balss, 1910, p. 8, fig. 2a.—Parisi, 1922, p. 103.—Komai, 1927, p. 323.—Komai, Akatsuka, and Ikari, 1927, p. 295.—Komai and Ikari, 1929, p. 121.—Gravier, 1930, p. 525.—Serène, 1937, p. 68 [listed].—Komai, 1938, p. 268.—Suvatti, 1938, p. 52.—Chopra, 1939, p. 158.—Liu, 1949, p. 43, pl. 6 (figs. 15–17).—Anonymous, 1949, p. 843, fig. 2421.—Barnard, 1950, p. 851, figs. 1c, g.—Suvatti, 1950, p. 132.—Dawydoff, 1952, p. 145.—Serène, 1953, p. 507; 1954, pp. 6, 8, 62, pl. 4 (figs. 1–6).—Millard and Harrison, 1954, p. 176 [listed].—Day and Morgans, 1956, p. 306 [listed].—Utinomi, 1956, p. 91, pl. 46 (fig. 2) [colored figure].—Yamaji, 1959, fig. on p. 68.—Utinomi, 1960, p. 114, pl. 57 (fig. 7) [colored figure].—Chuang, 1961, pp. 181, 206, pl. 81 (fig. 4), lowest fig. on pl. 82.—Stephenson, 1962, p. 34.—Crosnier, 1965, p. 61 [listed]. [All = *H. harpax* (de Haan).]

not *Squilla raphidea.*—?Tate, 1883, p. 48.—Stephenson, 1952, p. 4; 1953, p. 43. [All probably = *H. stephensoni,* new species.]

not *Chloridella raphidea.*—Rathbun, 1902, p. 55. [=*H. japonica,* new species.]

not *Squilla raphidea.*—Fukuda, 1913, pp. 70, 72, fig. on p. 71. [=*H. japonica,* new species.]

not *Squilla raphidia.*—Torralbas, 1917, p. 621 [p. 81 on separate] [=*Squilla empusa* Say, 1818].

not *Squilla raphidoea.*—Serène, 1939, p. 349 [erroneous spelling; ?=*H. harpax*].

not *Squilla raphidea.*—Stephenson and McNeill, 1955, p. 239 [a mixture of *H. harpax* (de Haan), *H. melanoura* Manning, and *H. stephensoni,* new species].

MATERIAL.—1 ♀, 216 mm; Sandakan, North Borneo, Indonesia; Herre, col.; 30 June 1929; SI Crust. 125360.—2 ♀, 250–277 mm; Thailand; Hugh M.

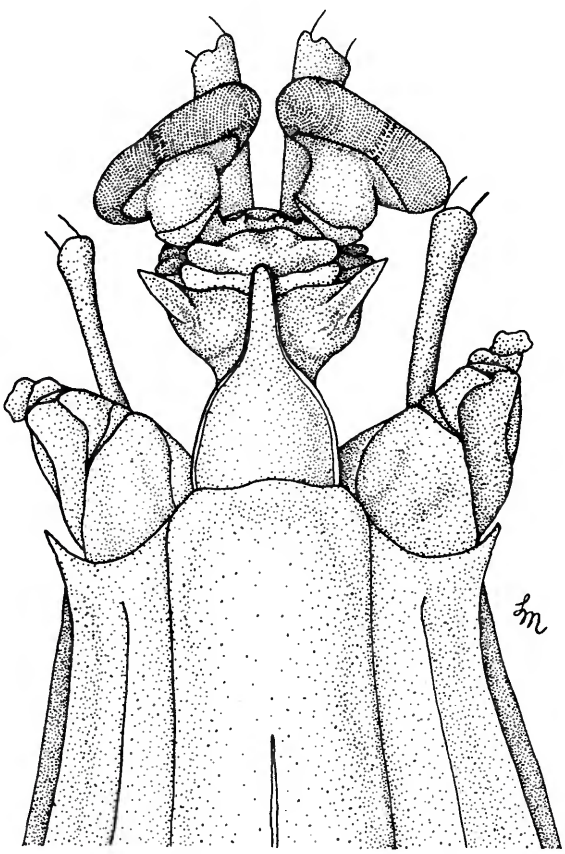

FIGURE 4.—*Harpiosquilla raphidea* (Fabricius). Female, TL 250 mm, Thailand: anterior portion of body.

FIGURE 5.—*Harpiosquilla raphidea* (Fabricius). Male, TL 310 mm, off Bombay: raptorial claw (propodus length 72.5 mm).

FIGURE 6.—*Harpiosquilla raphidea* (Fabricius). Female, TL 250 mm, Thailand: raptorial claw (propodus length 69.7 mm).

Smith; SI Crust. 93736.—1 ♀, 270 mm; Pak Poon [Pakpoon, western side of Gulf of Siam, Nakon Sritamarat Province], Thailand; Hugh M. Smith; 19 October 1923; SI Crust. 69530.—1 ♂, CL 56.0 mm; same; SI Crust. 106388.—1 ♂, 310 mm; taken with a 60 mile radius of Bombay, India; C. L. Kaufmann; SI Crust. 104363.

DIAGNOSIS.—Size large, adults with TL to 335 mm; antennular peduncle shorter than carapace; corneal indices ranging between 380 and 530 (Table 1); rostral plate (Figure 4) longer than broad, with slender anterior projection; carapace with median carina; upper margin of propodus of claw usually with 1 smaller spine or denticle between largest spines; dactylus of claw with 8 teeth, outer margin with prominent angular projection in adult males (Figure 5); fifth thoracic somite (Figure 7) with lateral spine; posterior 3 thoracic somites with submedian and intermediate carinae, intermediates spined posteriorly; ventral keel of eighth thoracic somite rounded; all 6 abdominal somites with submedian carinae, abdominal carinae spined as follows: submedian 6, intermediate 1–6, lateral 1–6, marginal 1–5; denticles rounded, 4–5, 8, 1; marginal carina about twice as long as carina of lateral tooth, usually fused with it in large specimens; postanal carina extending about halfway between anus and posterior margin; proximal portion of inner half of distal segment of uropodal exopod with dark pigment.

COLOR.—The color pattern is not well marked in any of the specimens examined. Posterior 3 thoracic and first 5 abdominal somites each with dark posterior line; fifth thoracic somite with dark anterior line; telson with proximal pair of dark spots; uropodal exopod with dark spot, primarily on inner surface, on distal third of proximal segment; some dark pigment on inner proximal third of distal segment of uropodal exopod, but inner half of distal segment not completely dark.

Tirmizi and Manning (1968, p. 33) noted that a fresh specimen from Karachi, West Pakistan was colored as follows:

> . . . ocular peduncles light pink; posterior border of carapace with a black band; antennal scale yellowish, outlined with dark pigment; claw with merus pink, also marked with a greenish yellow patch; distal end of propodus with bright yellow streak; thorax and abdomen appearing speckled; last 3 thoracic and first 3 abdominal somites pink, last 3 abdominal somites more cream-colored; tips of spines of last 4 abdominal somites yellow; posterior margin of first 4 abdominal somites black; carinae of telson bluish, apices of teeth yellow; telson with pair of submedian yellow-brown spots;

uropod lightly marked with yellow and black, inner half of distal segment of exopod grayish, outer half yellow.

SIZE.—Only intact male examined, TL 310 mm; females, TL 216–277 mm. Males ranging between 197–275 mm TL and females ranging between 160–288 mm TL have been recorded in the literature. Kemp (1913) recorded a specimen of TL 335 mm but did not specify its sex.

Other measurements of a female, TL 277 mm: carapace length 57.0; cornea width 12.0; antennular peduncle length 42.0; rostral plate length 13.6, width 8.2; raptorial propodus length 81.4; fifth abdominal somite width 59.8; telson length 52.4, width 54.3.

DISCUSSION.—Several of the features of *H. raphidea* allow its ready separation from the other known species of the genus. It shares with *H. annandalei* the sharp lateral process on the fifth thoracic somite (Figure 7), and the armed intermediate carinae of the posterior three thoracic and all six abdominal somites; these two features will distinguish it from the five other species. It differs from *H. annandalei* in several characters over and above color pattern and size of adults, for the submedian carinae of the fifth abdominal somite are unarmed, the rostral plate is elongate, with a slender median projection (Figure 4), and adult males of *H. raphidea* have the large angled prominence on the outer margin of the dactylus of the claw (Figure 5). As noted under the Discussion of *H. annandalei* (p. 7), the color pattern of that species is quite distinctive.

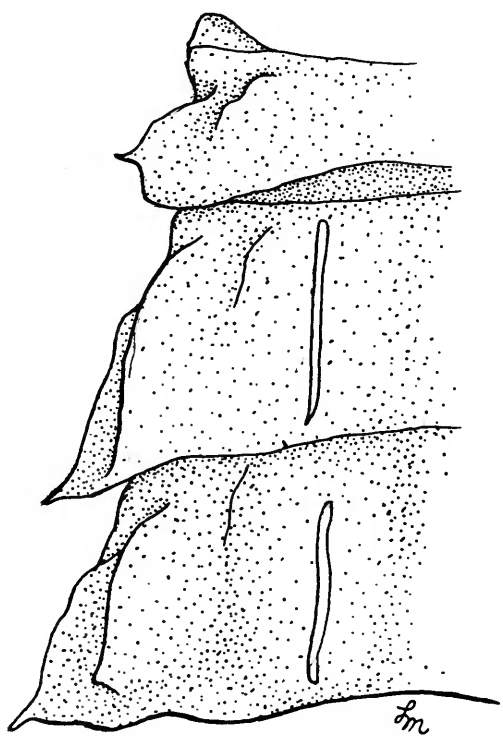

FIGURE 7.—*Harpiosquilla raphidea* (Fabricius). Female TL 250 mm, Thailand: lateral processes of fifth, sixth, and seventh thoracic somites.

Harpiosquilla raphidea is the largest known stomatopod; Kemp (1913) recorded a specimen from Bombay with a total length of 335 mm. In very large specimens, as in the male, TL 310 mm, recorded here from Bombay, the marginal teeth of the telson are markedly compressed and inflated. The lobe between the spines of the basal prolongation of the uropod becomes comparatively smaller with increasing size. Inflation of the carinae of the marginal teeth of the telson in adults smooths out the normal dorsal rugosity of these carinae.

Two authors have recorded specimens with nine rather than eight teeth on the dactylus of the raptorial claw. Lanchester (1906) noted that a male from Patani Bay, Halmahera, had nine spines on the left dactylus and Roxas and Estampador (1930) reported that their specimens had nine, rarely eight teeth, on the claw. The latter authors may have been dealing with another species, for their specimens were under 160 mm TL.

The structure of the dorsal organ of this species was discussed by Hansen (1921).

SYNONYMY.—Inasmuch as *H. raphidea* was the only species in the genus which was recognized between 1798 and 1911, when Kemp described *annandalei,* and which was considered to include all specimens distinct from *annandalei* between 1911 and 1952, it is not surprising to find that the literature is quite confused; many of the records of *raphidea* in the literature could refer to one or more of the six other species recognized herein. Some of the records here referred to *raphidea* may include that species and other species as well.

Many of Kemp's (1913) records were verified by Tiwari and Biswas (1952) in their account in which *H. harpax* (de Haan) was shown to be distinct from *H. raphidea;* the latter authors also verified identifications of some material reported on by Chopra (1934). These verified records have been used to com-

pile the distribution of the species as recorded in the literature.

Balss (1910) distinguished his variety *africana* from *raphidea sensu stricto* by the shape of the rostral plate (which he illustrated), the presence of well-developed keels on the abdomen and telson, and the well-developed teeth of the telson. His *raphidea sensu stricto* is apparently *H. harpax* whereas his *africana* is *raphidea sensu stricto.*

Sunier (1918) has clearly illustrated a specimen of *raphidea;* the distinctive lateral process of the fifth thoracic somite and telson are easily discernible.

In his account of postlarval development and growth of *raphidea,* Alikunhi (1967) notes that according to the features discussed by Tiwari and Biswas (1952) his juveniles should be referred to *harpax.* He mentions, however, that at one stage the juveniles have all of the intermediate carinae of the abdomen provided with spines. This is a feature always found in *H. raphidea* and rarely found in *H. harpax,* for the intermediate carinae of the first abdominal somite are usually unarmed in *H. harpax.* It seems likely that Alikunhi was dealing with specimens of both species. Adults of both species occur on the eastern coast of India.

As noted under Distribution (p. 15), most records in the literature require verification.

SEXUAL DIMORPHISM.—As in most other species of *Harpiosquilla,* large males exhibit marked changes in the morphology of the raptorial claw and the telson; to a lesser extent the carinae of the sixth abdominal somite are also affected. The outer margin of the dactylus of the claw in the male (Figure 5) has a large, angled protuberance and the bases of the teeth on the inner margin of the dactylus, particularly the second through the fifth tooth, have basal inflations. The carinae of the sixth abdominal somite, especially the submedians, are inflated in large adults of both sexes, but they are more inflated in the males; in some specimens the posterior spines of the submedian teeth are obsolete. In adult males (Figure 8), the median carina of the telson is so inflated that it may obliterate the distal dorsal spine. The carinae of the marginal teeth are also inflated; usually the marginal and lateral carinae of the telson are completely fused. Claws (Figures 5, 6) and telsons (Figures 8, 9) of both males and females have been illustrated. Although the carinae of the telson are also inflated in adult females, as in the specimen from Thailand, TL 250 mm, illustrated here, the extent of inflation is never so great as in males of similar size.

There is no information available on the size at which males begin to exhibit dimorphism, but Alikunhi (1967, p. 903) noted that: "Sexual maturity is not

FIGURE 8.—*Harpiosquilla raphidea* (Fabricius). Male, TL 310 mm, off Bombay: posterior portion of body (telson width 55.8 mm).

FIGURE 9.—*Harpiosquilla raphidea* (Fabricius). Female, TL 250 mm, Thailand: posterior portion of body (telson width 48.1 mm).

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attained even after the 15th moult after metamorphosis. Other specimens up to 137.0 mm in length were also found immature in March."

Kemp (1918) noted that one male from Tale Sap, Thailand, TL 200 mm, lacked an angular projection on the claw.

BIOLOGY.—As in the other species of *Harpiosquilla,* very little is known about the biology of *H. raphidea.* It occurs in relatively shallow water; the few depth records in the literature indicate that it has been taken in depths between 1 and 28 fathoms. Kemp (1918) noted that it was taken in brackish water, specific gravity 1.0085, at Tale Sap, Thailand.

Several authors have reported specimens from local fish markets, so it may have economic importance in some areas and it may be collected in connection with commercial fishing operations. It has been recorded from markets in Karachi, West Pakistan (Tirmizi and Manning, 1968), Singapore (Tweedie, 1934), Sarawak (Tiwari and Biswas, 1952), Divisoria Market, Manila (Kemp, 1915), and markets in Manila (Roxas and Estampador, 1930); the specimens from Thailand reported by Kemp (1918) were taken in fishermen's nets.

Smedley (1927) commented that *raphidea* was the commonest of local mantis shrimps at Morib, on the west coast of the Malay peninsula.

Sunier (1918) found fragments of the shrimp *Penaeus indicus* Milne-Edwards in the stomachs of two specimens and Brachyurum [Brachyura?] in the stomach of a third.

There is no information available on other stomatopods or invertebrates associated with this species.

Postlarval development and changes with age have been discussed in some detail by Alikunhi (1967).

DEVELOPMENT.—Nair (1941) discussed egg extrusion and embrological development in a species from Madras, India, identified by him as *Squilla raphidea;* he also made observations on the embryology of *Oratosquilla holoschista* (Kemp), *O. nepa* (Latreille), and *O. woodmasoni* (Kemp).

Alikunhi (1952) has given a detailed account of a larval form identified by him as *raphidea;* Alikunhi and Aiyar (1942, 1943) and Alikunhi (1950) had previously reported the metamorphosis of a larva into postlarval and juvenile *raphidea.* In an abstract of a paper presented at the Symposium on Crustacea sponsored by The Marine Biological Association of India, Alikunhi (1965) noted that *raphidea* was among eighteen species from the Madras coast, the postlarval development of which was well known.

In the paper presented at the Symposium and published in Part II of the Proceedings of the Symposium on Crustacea, Alikunhi (1967) has presented results of the most detailed study of growth in stomatopods ever made. Aspects of postlarval growth are reported in varying detail for eighteen species, including *raphidea.* Of particular interest is the fact that the movable submedian teeth of the postlarva are retained beyond that stage in *Harpiosquilla.* Although Alikunhi identifies his material with *raphidea* and mentions that by the twelfth molt the intermediate carinae of the first and second abdominal somites are armed posteriorly, a characteristic of adult *raphidea,* he notes on p. 904 that according to the diagnostic characters of *harpax* and *raphidea* the reared material actually belongs to *harpax.* It seems highly likely that both species were represented in his material.

Alikunhi (1952) identified his larva with *Alimerichthus* sp. Claus (1871) from the Indian Ocean and with *Alimerichthus pyramidalis* Lanchester, 1903 from North Male Atoll, Maldive Islands; Lanchester had identified his larva with Claus' species and with an *Alimerichthus* reported by Brooks (1886, pp. 95–98). Brook's larvae, however, were from the Atlantic and are not likely to be the larvae of an Indo-West Pacific species.

Alikunhi noted that his series of larvae from Madras included two distinct forms. He identified his typical larva with *H. raphidea* and stated (1952, p. 267):

> The post-larva obtained by moult from one such larva more or less agrees with *S. raphidea.* However, since the early post-larvae in most cases do not show the full adult characters and since *S. raphidea* and *S. annendalei* [sic] are very closely related, it is a possibility that the atypical larva probably belongs to the latter species. This is, however, just a surmise which is not based on any positive evidence.

Alikunhi (1952, p. 269) also noted that *Erichthus multispinus* Claus, identified with *H. raphidea* by Foxon (1939), "appears to be a very different species, probably not related to *S. raphidea,* even though it also possesses laterally directed spinules on the carapace. Borradaile's [1907] specimens are perhaps identical with the specimen figured by Claus."

TYPE.—Probably not extant. Zimsen (1964) did not locate the type in her comprehensive survey of Fabrician types.

TYPE-LOCALITY.—Oceano Indico D. Daldorff. I. K. Daldorff collected material for Fabricius at Fredericks-

nagore, on the eastern coast of India. Fredericksnagore, located on the Hooghly River, north of Calcutta, is now known as Serampore (Webster's Geographical Dictionary, Rev. Ed., 1966).

DISTRIBUTION.—Indo-West Pacific region, from Indonesia and the Gulf of Siam westward to East Africa. Most of the records in the literature probably refer to *H. harpax, H. indica,* new species, or *H. melanoura* as well as *H. raphidea;* from most accounts it is not possible to determine which species was actually being recorded. The following records are probably referable to *H. raphidea*: SOUTH CHINA SEA: NE of Tegal, 06°53′N, 110°21′E, 6.5–9 fms (Sunier, 1918). INDONESIA: Indischen Archipel (de Man, 1898); Java Sea, between Singapore and Surabaya [Surabaja, Java] (? part; de Man, 1898); Borneo Bank, Makassar Strait, 15 fms; Madura Strait, ca. 16 fms; Java Sea, N. of western Madura, 7.5 fms; vicinity of Madura; near Tandjong Priok, Batavia [Djakarta], less than 1 fm; same, 6–7 fms; beyond western entrance of Banka Strait, Sumatra, 5–8 fms; outside of estuary of Rokan River, Sumatra, 18–20 fms; Bagan Si Api Api, eastern Sumatra; east coast of Sumatra (all Sunier, 1918). MALAYSIA: Singapore (Kemp, 1913; Tiwari and Biswas, 1952); Penang, 11 fms (Sunier, 1918); Kuching Fish Market, Sarawak (Tiwari and Biswas, 1952). THAILAND: (?) Tale Sap (Kemp, 1918; Tiwari and Biswas, 1952). INDIAN OCEAN: (Fabricius, 1798). BAY OF BENGAL: north and south of Eastern Channel (Tiwari and Biswas, 1952). EAST PAKISTAN: Cox's Bazaar (Tirmizi and Manning, 1968). INDIA: Sunderbans [Sundarbans] (Tiwari and Biswas, 1952); Sandheads, mouth of River Hughli [Hooghly; including Saugor Island] (Kemp, 1913; Chopra, 1934; Tiwari and Biswas, 1952); Calcutta Bazaar (Tiwari and Biswas, 1952); Chandipur, Balasore (Tiwari and Biswas, 1952); off Puri (Kemp, 1913; Tiwari and Biswas, 1952); Bombay (Kemp, 1913; Chhapgar and Sane, 1968). WEST PAKISTAN: Karachi (Tirmizi and Manning, 1968). EAST AFRICA: (Balss, 1910).

The following records need to be verified; all fall within the known range of *H. raphidea* but it is not possible to determine with certainty the identity of the species reported by each author. PHILIPPINE ISLANDS: Philippines (Holthuis, 1941); Manila Bay (Roxas and Estampador, 1930); Divisoria Market, Manila (Kemp 1915); Cebu (Roxas and Estampador, 1930); Davao Gulf, Mindanao (Roxas and Estampador, 1930). INDONESIA: Dutch East Indies; Skroe, Dutch New Guinea; Amboina; Haroekoe (all Holthuis, 1941); Patani Bay, Halmahera (Lanchester, 1906); Moluccas (Holthuis, 1941); Kisar, near Timor (Holthuis, 1941); Borneo (Miers, 1880); Sandakan, northeast Borneo; Balikpapan, east Borneo; Java; Java Sea (all Holthuis, 1941); Madura (Thallwitz, 1892); Batavia [Djakarta] (Preudhomme de Borre, 1882); Bay of Batavia [Djakarta]; Tandjong Priok, near Batavia [Djakarta]; Cheribon, Java; Deli, east Sumatra; mouth of Djambi River, east coast of Sumatra; Padang, west coast of Sumatra; coast of Atyeh, Sumatra; Telok Dalam, Nias (all Holthuis, 1941). MALAYASIA: Singapore (Nobili, 1903); Siglap, Singapore (Tweedie, 1934); Morib (Smedley, 1927); Kota Bharu (Lanchester, 1901); [?] Moratabas (Lanchester, 1900); Malacca (Sharp, 1893). THAILAND: Singora (Lanchester, 1901). INDIAN OCEAN: (Bosc, 1801–1802, 1830; Latreille, 1802; Lamarck, 1818; Milne-Edwards, 1837; Deshayés and Milne-Edwards, 1838, 1839). ANDAMAN ISLANDS: Port Blair (Kemp, 1913). BURMA: Mergui Archipelago (de Man, 1888; Kemp, 1913); off Irrawaddy Delta, 15°20′N, 94°55′E, 20 fms (Kemp, 1913); Rangoon (Kemp, 1913); Akyab, Tenasserim (Kemp, 1913). INDIA: no specific locality (Sharp, 1893); Sunderbunds [Sundarbans] (Henderson, 1893); off Gopalpur, Ganjan coast, 25–28 fms (Kemp, 1913); Indes Orientales, Pondichéry (Latreille, 1828); Madras (Henderson, 1893; Nair, 1941; Gravely, 1941); Pámban, Gulf of Manaar [Mannar] (Thurston, 1895); Krusadai Island, Gulf of Mannar (Chacko, 1942); Bombay Harbour, Bombay [part?] (Kemp, 1913). CEYLON: (Kemp, 1913). WEST PAKISTAN: Karachi (Kemp, 1913). PERSIAN GULF: 28°59′N, 50°05′E, 25 fms (Kemp, 1913).

Larvae attributed to *H. raphidea* have been recorded from the following localities: INDIAN OCEAN: (Claus, 1871). INDIA: Madras (Alikunhi and Aiyar, 1942, 1943; Alikunhi, 1950, 1952, 1965, 1967. MALDIVE ISLANDS: North Male Atoll, 27–35 fms (Lanchester, 1903). EAST AFRICA: Mozambique Channel (Ingle and Della Croce, 1967).

3. *Harpiosquilla japonica,* new species

FIGURES 10–11

Chloridella raphidea.—Rathbun, 1902, p. 55 [not *Squilla raphidea* Fabricius].

Squilla raphidea.—Fukuda, 1913, pp. 70, 72, figure on p. 71 [not *S. raphidea* Fabricius] [in Japanese].

HOLOTYPE.—1 ♀, 172 mm; Wakanoura, Kii, Japan; Jordan and Snyder, col.; 1900; SI Crust. 26340.

PARATYPES.—1 ♂, 165 mm; 1 ♀, 135 mm; data as in holotype; SI Crust. 125718.

DIAGNOSIS.—Size moderate, adults with TL less than 175 mm; antennular peduncle not so long as carapace; corneal indices ranging between 325 and 337 (Table 1); rostral plate (Figure 10) with length and width subequal, apex rounded or obtusely angled, lacking slender anterior projection; carapace with median carina; upper margin of propodus of claw with smaller spines and denticles between largest spines; dactylus of claw with 8 teeth; fifth thoracic somite (Figure 11) rounded laterally; posterior 3 thoracic somites with submedian and intermediate carinae, none armed posteriorly; ventral keel of eighth thoracic somite rounded; all 6 abdominal somites with submedian carinae, abdominal carinae spined as follows: submedian 6, intermediate 3–6, lateral 1–6, marginal 1–5; denticles 4–6, 10–11, 1; marginal carina of telson less than twice as long as carina of lateral tooth; postanal keel extending about halfway between anus and posterior margin; color of uropodal exopod unknown.

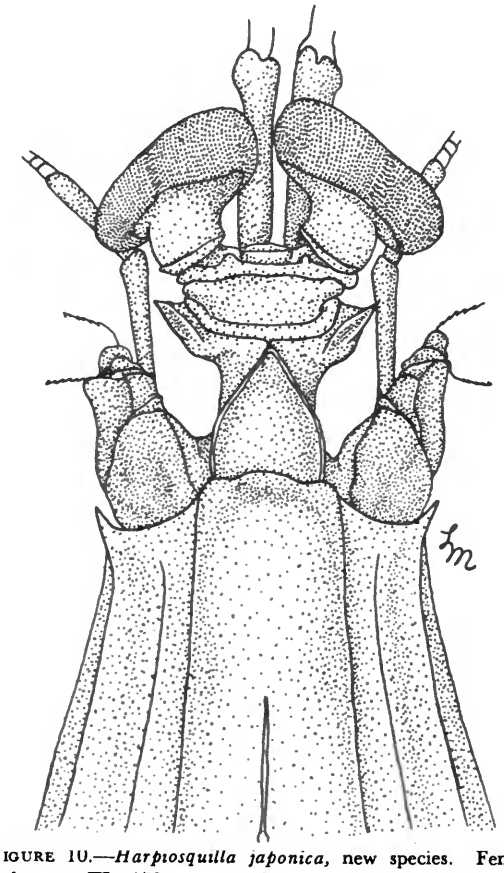


FIGURE 10.—*Harpiosquilla japonica,* new species. Female holotype, TL 172 mm, Wakanoura: anterior portion of body.

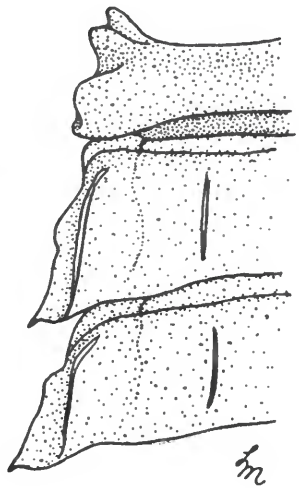


FIGURE 11.—*Harpiosquilla japonica,* new species. Female holotype, TL 172 mm, Wakanoura: lateral processes of fifth, sixth, and seventh thoracic somites.

COLOR.—Completely faded in the type-specimens.

SIZE.—Only male examined, TL 165 mm; females TL 135–172 mm.

Other measurements (in mm) of male: carapace length 34.1; cornea width 10.5; antennular peduncle length 32.4; rostral plate length 5.4, width 5.4; fifth abdominal somite width 35.3; telson length 31.3, width 30.3.

DISCUSSION.—*Harpiosquilla japonica,* new species, resembles both *H. annandalei* and *H. stephensoni,* new species, and differs from the remainder of the species in the genus in having a short rostral plate, as broad as long, without an anterior projection. *Harpiosquilla annandalei* differs in numerous features, as noted under the discussion of that species, and it can be distinguished immediately from *H. japonica* by the presence of armed submedian carinae on the fifth abdominal somite. *Harpiosquilla stephensoni* and *H. japonica* are very similar in general facies, but they can be distinguished readily by the characters used in the key, namely (1) the presence of eight teeth on the claw of *H. japonica,* seven on *H. stephensoni;* (2) the intermediate carinae of the second abdominal somite are unarmed in *H. japonica,* spined posteriorly in *H. stephensoni,* and (3) the lateral process of the fifth

abdominal somite is rounded in *H. japonica,* angled or spined in *H. stephensoni.* The last feature may be of limited value in distinguishing specimens of *H. japonica* from smaller specimens of *H. stephensoni,* for, as noted under the Discussion (p. 19) of the latter species, small adults may not have the projecting lateral process well developed.

Although the corneal indices of *H. japonica,* new species, overlap those of the smallest specimen of *H. stephensoni,* new species, examined for this study, the eyes of the two species differ in shape when two specimens of similar size are compared. The lobes of the cornea are more inflated in *H. stephensoni* and the eye appears smaller in that species.

I have previously assumed that records of *H. raphidea* from Japanese waters are referable to *H. harpax,* for *H. raphidea* is not known to occur that far northward. However, some of the specimens reported in the literature may well be *H. japonica,* new species. Fukuda (1913) clearly shows a short rostral plate, short marginal carinae on the telson, and relatively strong submedian carinae on the abdomen, all of which are characteristic of *H. japonica* rather than *H. harpax.*

Although Rathbun (1902) reported five specimens in the lot collected by Jordan and Snyder, only three are now in the collections of the Division of Crustacea, National Museum of Natural History, Smithsonian Institution. The other two specimens probably were returned to Stanford University and may now be housed in the collections of the California Academy of Sciences.

SEXUAL DEMORPHISM.—The male paratype lacks raptorial claws, so no comparison of that appendage can be made with the claw of the female (only one female, the holotype, has claws). The median carina of the telson in the male is slightly more inflated than that of each female.

BIOLOGY.—Unknown.

DEVELOPMENT.—Unknown.

TYPES.—The holotype and two paratypes are in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution.

TYPE-LOCALITY.—Wakanoura, Kii, Japan.

NAME.—The name refers to the occurrence of the species off Japan.

DISTRIBUTION.—Known only from Japan. Fukuda's article is in Japanese so I cannot determine whether he mentioned any specific localities.

4. *Harpiosquilla stephensoni,* new species

FIGURES 12–17

?Squilla sp. [*Alima pyramidalis*].—Foxon, 1932, p. 381 [larva; ? several species; identification questioned by Ingle and Della Croce, 1967].

Squilla raphidea.—Tate, 1883, p. 48 [?].—Stephenson, 1952, p. 4; 1953, p. 43 [part?].—Stephenson and McNeill, 1955, p. 239 [part] [not *S. raphidea* Fabricius].

Harpiosquilla harpax.—Manning, 1966, p. 87, fig. 1 [not *S. harpax* de Haan].

Harpiosquilla sp.—Manning, 1968a, fig. 4.

HOLOTYPE.—1 ♀, 315 mm; Port Curtis, Queensland, Australia; seine net over flat; no other data; AM P-9664.

PARATYPES.—1 ♀, 220 mm; near Emery Point, Darwin Harbour, Northern Territory; taken in seine net

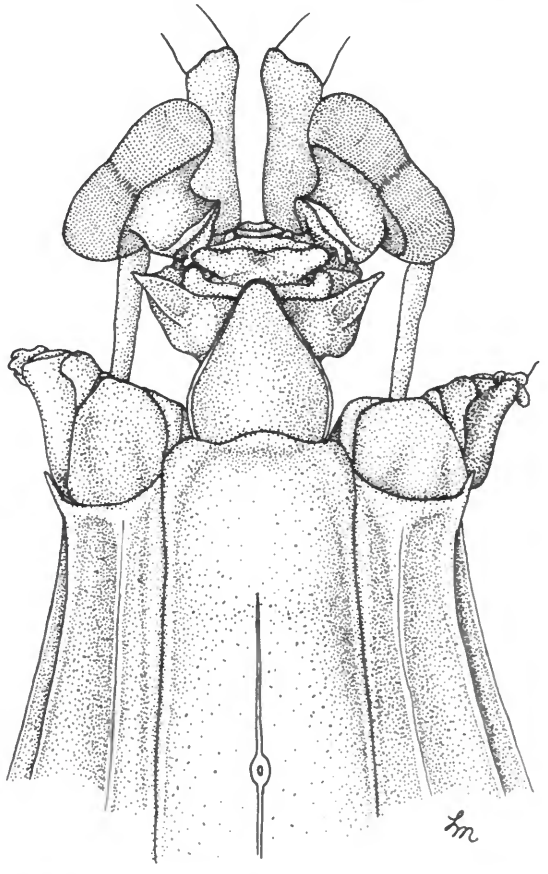


FIGURE 12.—*Harpiosquilla stephensoni,* new species. Male paratype, TL 272 mm, Port Curtis: anterior portion of body.

FIGURE 13.—*Harpiosquilla stephensoni,* new species. Male paratype, TL 272 mm, Port Curtis: raptorial claw (propodus length 63.0 mm).

FIGURE 14.—*Harpiosquilla stephensoni,* new species. Female holotype TL 315 mm, Port Curtis: raptorial claw (propodus length 79.2 mm).

off beach; Capt. E. F. Wells, col.; early 1954; AM P–12382.—1 ♀, 170 mm; same data; SI Crust. 111354. —1 ♀, 168 mm; Darwin Harbour, Northern Territory; no other data; AM P–12770.—1 ♀, 240 mm; same; in 60 ft; C. W. Holman, col.; 2 July 1962; AM P–14924. —4 ♂, 136–202 mm; 1 ♀, 135 mm; southern Gulf of Carpentaria, Queensland; 14 fms or less; CSIRO Prawn Survey; December 1963; AM P–15503 to P–15507.—1 ♂, 208 mm; southeastern Gulf of Carpentaria, Queensland; 14 fms or less; CSIRO Prawn Survey; December 1963; AM P–15509.—1 broken ♀, CL 51.6 mm; Cairns Inlet, northern Queensland; AM P–9685.—1 ♀, 245 mm; Port Curtis area, Queensland; M. Ward and W. Boardman, col.; July 1929; AM P–14925.—1 ♀, 277 mm; same; AM P–14926.—1 ♂, 272 mm; Port Curtis, Queensland; SI Crust. 125720.

DIAGNOSIS.—Size large, adults with TL to 315 mm; antennular peduncle shorter than carapace; corneal indices ranging between 336 and 434 (Table 1); rostral plate (Figure 12) as long as or slightly longer than broad, apex obtusely angled or rounded, not projecting anteriorly; carapace with median carina; upper margin of propodus of claw with smaller spines and denticles between largest spines; dactylus of claw with 7 teeth, outer margin of dactylus (Figure 13) with prominent obtusely rounded projection in adult males; fifth thoracic somite (Figure 15) angled laterally or with lateral acute projection; last 3 thoracic somites with submedian and intermediate carinae, intermediates unarmed; ventral keel of eighth thoracic somite rounded; submedian carinae present on all 6 abdominal somites, abdominal carinae armed as follows: submedian 6, intermediate 2–6, lateral 1–6, marginal 1–5; denticles 4–6, 6–11, 1, usually 5–6, 7–8, 1; marginal carina less than twice as long as carina of lateral tooth; postanal keel extending slightly more than halfway between anus and posterior margin; at most inner half of distal segment of uropodal exopod dark.

COLOR.—Black transverse line present on dorsum between antennular and ophthalmic somites; antennal scale lacking any marked concentration of dark pigment; carinae, grooves, and both anterior and posterior margins of carapace dark; display patch on dorsal surface of merus yellow, with proximal dark oval bar; last 3 thoracic and first 5 abdominal somites with dark posterior line and irregular dark area on dorsum; telson with pair of oval or elongate dark spots on anterior dorsal surface; proximal portion of anterior margin of uropod dark; proximal segment of uropodal exopod with inner dark patch, distal segment with dark, diffuse pigment on inner half or third; distal half of endopod darker than proximal, but apex light.

J. C. Yaldwyn made available a color slide taken by D. F. McMichael of one specimen, AM P–15507. Most of the pattern mentioned above is visible. The background color of the body is ivory. The major difference from the pattern on the same specimen in preservative is that there is but one anterior, elongate patch of dark pigment on the telson; it is not broken into two submedian patches.

SIZE.—Males TL 136–272 mm; females TL 135–315 mm. Only *H. raphidea,* among the currently known species of *Harpiosquilla,* grows to such a large size; it is known to reach 335 mm in total length.

Other measurements of female holotype, TL 315 mm: carapace length 59.1; cornea width 14.4; antennular peduncle length 46.7; rostral plate length 10.9, width 9.9; raptorial propodus length 79.2; fifth abdominal somite width 61.4; telson length 57.2, width 55.6.

DISCUSSION.—The short rostral plate of this species (Figure 12), a feature which it shares with *H. annandalei* and *H. japonica,* new species, will distinguish it from *H. harpax, H. indica,* new species, *H. melanoura,* and *raphidea. H. stephensoni,* new species, differs from *H. annandalei* in many features, including size of adults and color pattern, but the absence of spines on the submedian carinae of the fifth abdominal somite in *H. stephensoni* is the best way to separate the two species.

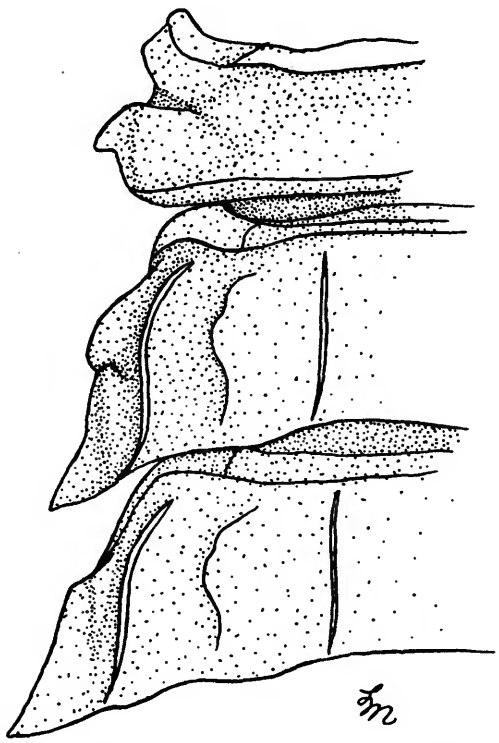


FIGURE 15.—*Harpiosquilla stephensoni,* new species. Male paratype, TL 272 mm, Port Curtis: lateral processes of fifth, sixth, and seventh thoracic somites.

Harpiosquilla stephensoni, is very similar to *H. japonica,* described above. However, *H. japonica* differs in having eight teeth on the claw, unarmed intermediate carinae on the abdomen anterior to the third somite, and the lateral process of the fifth thoracic somite is rounded, not angled posterolaterally. The submedian carinae of the abdomen are more prominent in *H. stephensoni* than in *H. japonica.*

Although the corneal indices of *H. stephensoni* and *H. japonica* overlap, the eyes of *H. japonica* appear to be larger when specimens of similar size are compared. *Harpiosquilla japonica* is probably a smaller species, for the single male examined, TL 165 mm, shows signs of inflation of the median carina of the telson, a secondary sexual feature characteristic of adult males. See also the remarks under the account of *H. japonica,* new species (p. 15).

Adult specimens (TL 200–225 mm or more) differ from younger ones in having the lateral process of the fifth thoracic somite shaped differently. In adults (Figure 15) the edge of the lateral process slopes posterolaterally to an acute angle, the apex of which may form a blunt tubercle or spine. The spine, if present, is never so well developed as in *H. annandalei* or *H. raphidea.* The lateral process of subadult specimens is not so markedly angled posterolaterally. However, juveniles of *H. stephensoni* can be distinguished by the other features cited above.

Corneal indices for *H. stephensoni,* new species, are summarized in Table 1. They overlap those of *H. harpax* to some extent, but the eyes of the largest specimens of *H. harpax* are about the same size as those of the smallest specimens of *H. stephensoni,* and the lobes of the cornea are not as inflated as in the latter species. The eyes of the smaller specimens of *H. raphidea* reported herein are similar in size to those of the largest specimen of *H. stephensoni,* but the eyes of large specimens of *H. raphidea* are much smaller.

Specimens recorded as *S. raphidea* by Stephenson and McNeill (1955) from Darwin Harbour (2 ♀), to belong to *H. stephensoni.* Most of the remainder of the specimens reported by Stephenson and McNeill are referred herein to *H. harpax;* one specimen proved to be *H. melanoura.* It is likely that some of the specimens from Queensland recorded as *S. raphidea* by Stephenson (1952, 1953) belong to *H. harpax,* but I

FIGURE 16.—*Harpiosquilla stephensoni*, new species. Male paratype, TL 272 mm, Port Curtis: posterior portion of body (telson width 45.3 mm).

FIGURE 17.—*Harpiosquilla stephensoni*, new species. Female holotype, TL 315 mm, Port Curtis: posterior portion of body (telson width 55.6 mm).

include his records here because of the apparent abundance of *H. stephensoni* in Queensland waters.

In 1966 I reported on a specimen of *H. stephensoni* as *H. harpax* and noted that it differed from other specimens available for study in several features. Two of these, the convex lobe on the basal prolongation of the uropod and the elongate dark spots on the telson, have proved to be of little value. The two specimens from off Emery Point, Darwin Harbour, show both of these features but in other respects they appear to be typical subadult specimens of *H. stephensoni*. No other specimens have elongate spots on the telson but several show variation in shape of the lobe between the spines of the basal prolongation. I can only conclude that these features vary in this species.

The carinae of the marginal teeth of the telson in *H. stephensoni* are lined dorsally with large tubercles; the carinae appear nodulose in lateral view (Figures 16, 17). These tubercles are well defined in large specimens are are not obliterated in them as in *H. raphidea*. The carinae are inflated and the apices of the teeth are upturned. In these features *H. stephensoni* resembles *H. raphidea*, but the tubercles are much larger in the latter species.

The marginal denticles of the telson are less numerous, in general, than in other species of *Harpiosquilla*. They are also sharper and more distinct in smaller specimens than in the largest ones examined.

SEXUAL DIMORPHISM.—Males of TL 180 mm or more have secondary sexual characteristics similar to those found in some other species. There is a pronounced lobe, often irregular in outline, on the outer margin of the dactylus of the claw (Figure 13); it is not so sharply angled as in males of *H. raphidea*. The bases of the second to fifth dactylar teeth are inflated. The submedian carinae of the sixth abdominal somite and the median carina of the telson are also inflated in adult males (Figure 16), but the median carina of the telson in large females may also be very swollen. Claws (Figures 13, 14) and telsons (Figures 16, 17) of a large male and female have been illustrated.

BIOLOGY.—Relatively little information is available. Specimens have been taken in shallow water, 25 meters or less; three specimens were taken in seine nets. The range of the species in Australia overlaps that of *H. harpax* but whether both species occur together is not known.

One of the specimens from the southern Gulf of Carpentaria, AM P–15507, has numerous spherical egg cases, approximately 1.5 mm in diameter, attached to both the dorsal and ventral surfaces of the body; they are most numerous on the posterior portion. Many of the capsules had ruptured, but one was found to contain three small gastropods, each about 1.1 mm long. Commensals have not been recorded from members of this genus, and egg cases of other organisms are

rarely found on stomatopods. At the time of this writing, the egg cases had been identified tentatively by Dr. Joseph Rosewater, Division of Mollusks, Smithsonian Institution, as those of marginellid gastropods. Both marginellids and *Harpiosquilla* are burrowers, and possibly the adult gastropod used the *Harpiosquilla* in its burrow (?) as a substrate for attachment of its egg capsules.

DEVELOPMENT.—Larvae of this species are not known with certainty. Foxon (1932) reported on larvae from the Great Barrier Reef which she identified with *Alimerichthus pyramidalis* Lanchester; she also synonymized *A. unidens* Lanchester, 1903, and *Alimerichthus* a Tattersall, 1906, with *A. pyramidalis*. *A. pyramidalis* was subsequently identified with *H. raphidea* by Alikunhi (1952) who also pointed out that *A. unidens* and Tattersall's larva as well could be attributed to other species. Alikunhi (1952, p. 268) also noted: "That Foxon was dealing with a collection of species under the name *A. pyramidalis* is, therefore, obvious. Since larvae measuring 18 mm in length are reported in this collection, it is likely that *S. raphidea* is also represented in it."

However, Ingle and Della Croce (1967), who reexamined Foxon's material, stated (p. 67):

> Alikunhi (1952, p. 265) attributes Foxon's (1932, p. 381) material of *Alima pyramidalis* (Lanchester) to the adult species *Squilla raphidea* Fabricius. These particular specimens in the B.M. (N.H.) Collections do not quite correspond to Alikunhi's description and figures as most of them have spinule no. 5 . . . poorly developed and one or more teeth on the inner margin of the raptorial dactylus.

The possibility remains that Foxon was dealing with some larvae of either *H. harpax* or *H. stephensoni*, new species, both of which are common on the coast of Australia.

TYPE.—The holotype and most of the paratypes are in the Australian Museum, Sydney. One male and one female paratype are in the collections of the Division of Crustacea, National Museum of Natural History, Smithsonian Institution.

TYPE-LOCALITY.—Port Curtis, Queensland, Australia.

NAME.—The species is named for Professor W. Stephenson of the University of Queensland who has been instrumental in the development of our knowledge of Australian stomatopods.

DISTRIBUTION.—Known only from the coastal waters of Australia, where it has been taken from scattered localities between Darwin, Northern Territory, and Port Curtis, Queensland; shallow water to 14 fathoms. The following records in the literature may be based on material of this species. AUSTRALIA: Darwin, Northern Territory (Manning, 1966); probably Port Darwin, Northern Territory (Tate, 1883); Queensland (Stephenson, 1952); Cooktown, Queensland (Stephenson, 1953); Tambian Beach, Keppel Bay, Queensland (Stephenson and McNeill, 1955); Peel Island, Moreton Bay, Queensland (Stephenson, 1953); Woody Point Pier, Moreton Bay, Queensland, 10–11 m (Stephenson, 1952); 3 miles south of Woody Point Pier, Moreton Bay, Queensland, 6 m (Stephenson, 1952); 4 miles east of Scarborough Pier, Moreton Bay, Queensland, 10 m (Stephenson, 1952); and Southport, Queensland (Stephenson, 1953).

Stephenson (1952, 1953) may also have had *H. harpax* represented in his collections from Queensland.

Larvae of this species from the Great Barrier Reef may have been reported by Foxon (1932) as *Alima pryramidalis*.

5. *Harpiosquilla melanoura* Manning, 1968

FIGURES 18–27

Squilla raphidea.—Stephenson and McNeill, 1955, p. 239 [part] [not *S. raphidea* Fabricius].

Harpiosquilla melanoura Manning, 1968b, pp. 14 [key] 18, fig. 5.

MATERIAL.—1 ♂, 161 mm; Rose Bay, Port Jackson, New South Wales, Australia; in prawn net; 10 March 1925; AM P–7929.—1 ♀, 151 mm; Andaman Sea, Mergui Archipelago; 09°13′N, 97°51′E; 58–60 m; ANTON BRUUN Cruise 1, Sta. 20; IIOE; 23 March 1963; SI Crust. 125719.—1 ♀, 128 mm; Andaman Sea, off Burma; 14°07′N, 97°05′E; 69–73 m; ANTON BRUUN Cruise 1, Sta. 38; IIOE; 30 March 1963; SI Crust. 125358.

In addition to these specimens I have examined the type-series, 2 ♂, TL 102–129 mm, 2 ♀, TL 126–136 mm, from the Banc de Pracel, western coast of Madagascar.

DIAGNOSIS.—Size moderate, adults with TL less than 170 mm; antennular peduncle not so long as carapace and rostral plate combined; corneal indices ranging between 229 and 271 (Table 1); rostral plate (Figure 19) longer than broad, lateral margins tapering to slender median projection; carapace without median carina; upper margin of propodus of claw with smaller spines and denticles between largest spines;

FIGURE 18.—*Harpiosquilla melanoura* Manning. Female, TL 151 mm, Mergui Archipelago: dorsal view.

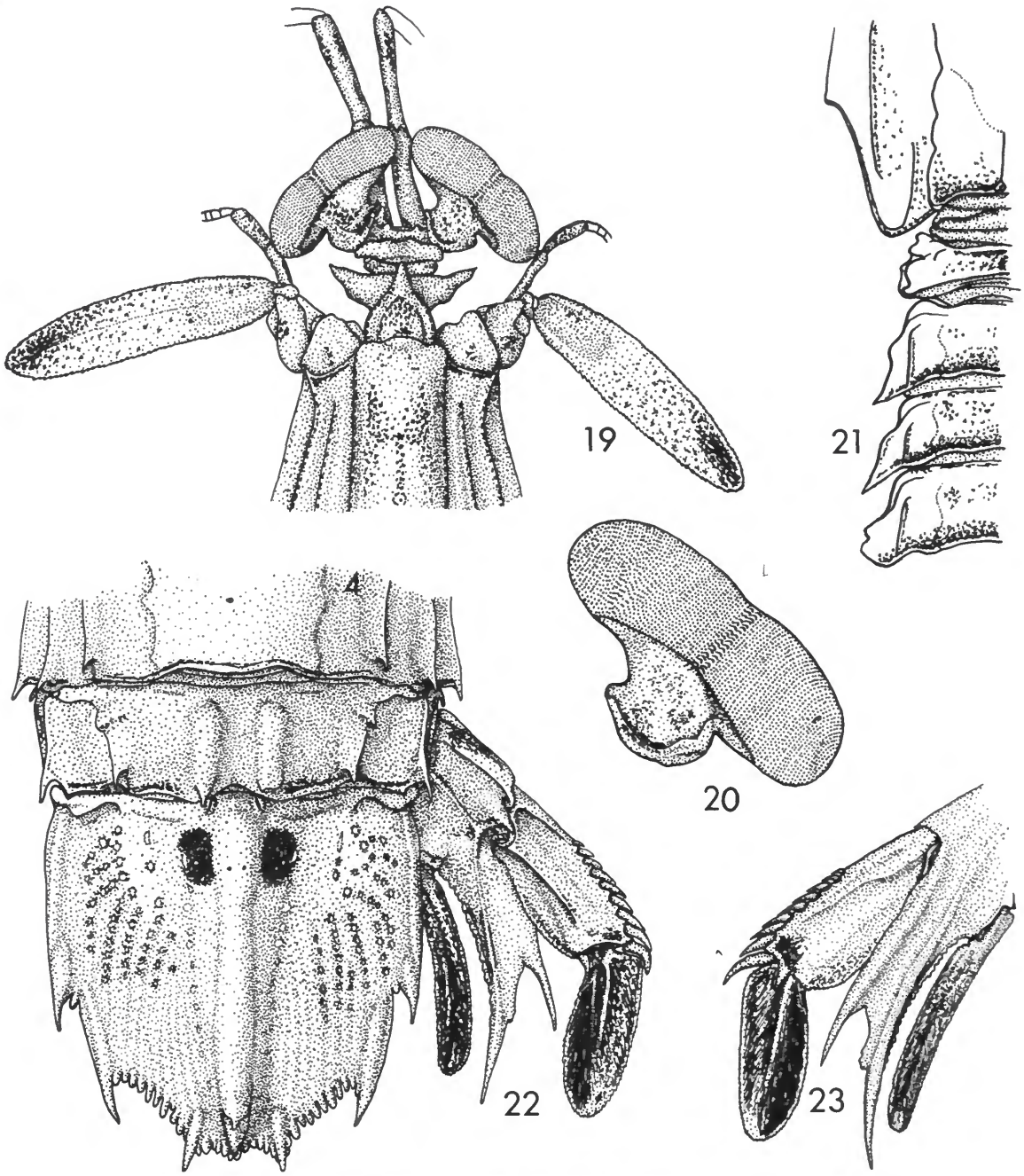
dactylus of claw with 8 teeth, outer margin of dactylus with prominent angular projection in adult males; fifth thoracic somite (Figure 21) rounded laterally; posterior 3 thoracic somites lacking submedian carinae; intermediate carinae of thoracic somites unarmed; ventral keel of eighth thoracic somite rounded; first to fifth abdominal somites lacking submedian carinae, abdominal carinae spined as follows: submedian 6, intermediate (2) 3–6, lateral 1–6, marginal 1–5; denticles 5–7, 9–12, 1; marginal carina of telson almost 3 times as long as carina of lateral tooth; postanal keel not extending halfway between anus and posterior margin; distal segment of uropodal jet black.

COLOR.—Inner and outer surfaces of antennular peduncles with distal black spot on each segment; anterolateral angle of antennal scale dark, anterointernal angle dark in some specimens; basal portion of rostral plate with oval area outlined with dark pigment; anterolateral margins, gastric grooves, and posterior median margin of carapace dark, median area, anterior to cervical groove, with dark oval patch; merus of claw with 3 dark spots, 1 at inner distal margin, 1 on proximal edge of dorsal depression, and 1 subdistally on outer surface; propodus of claw with inner and outer dark spot; posterior 3 thoracic and anterior 5 abdominal somites (sixth in some specimens) with posterior black lines; second abdominal somite with thin, transverse dark bar, traces of dark pigment also present medially on third to fifth somites; dorsal surface of telson with proximal submedian pair of oval dark spots, surface pits also dark; ventral surface of telson dark along midline, with dark patch at base of each tooth; anterior edge of basal segment of uropod dark; distal portion of proximal segment of uropodal exopod dark, distal segment of exopod jet black; distal half or two-thirds of endopod dark. The overall color pattern is shown in Figure 18.

SIZE.—Only male examined, TL 161 mm; females TL 128–151 mm. Including the type-series from Madagascar, males are known to range between TL 102–161 mm, females between TL 126–151 mm.

Other measurements of a female, TL 151 mm: carapace length 31.2; cornea width 11.5; antennular peduncle length 31.7; rostral plate length 6.4, width 5.0; raptorial propodus length 43.4; fifth abdominal somite width 32.2; telson length 28.5, width 27.6.

DISCUSSION.—*Harpiosquilla melanoura* is the only species in the genus lacking both the median carina of the carapace and the submedian carinae of the last



FIGURES 19–23.—*Harpiosquilla melanoura* Manning. Male holotype, TL 129 mm, Banc de Pracel, Madagascar: 19, anterior portion of body; 20, eye; 21, lateral processes of exposed thoracic somites; 22, last two abdominal somites, telson, and uropod; 23, uropod, ventral view (setae omitted; from Manning, 1968b).

three thoracic and first five abdominal somites. It further differs from all other species of *Harpiosquilla* now known in having the entire surface of the distal segment of the uropodal exopod jet black in color.

Harpiosquilla melanoura most closely resembles *H. indica,* new species, described herein, but the latter species has a well-developed median carina on the carapace. Other differences are discussed under *H. indica* (p. 33).

Corneal indices for *H. melanoura* are summarized in Table 1. The eyes of this species are similar in size to those of *H. harpax* but are slightly larger and more inflated.

The marginal carinae of the telson are comparatively longer in *H. melanoura* than in other species of *Harpiosquilla* for each is almost three times as long as the carina of the lateral tooth. *H. harpax* is the only other species in which the marginal carina is more than twice as long as that of the lateral tooth.

Of the seven specimens of this species now known, only one has the intermediate carinae of the second abdominal somite armed posteriorly. In the other specimens the intermediate carinae of the third to sixth somites only are provided with posterior spines.

SEXUAL DIMORPHISM.—Large males (TL 129 mm or more) (Figure 24) have a well-developed obtuse projection on the outer margin of the dactylus of the claw and the bases of individual teeth on the claw are noticeably inflated. Claws of a male and a female are shown in Figures 24 and 25. Males also differ from females in having the submedian carinae of the sixth abdominal somite and the median carina of the telson more inflated (Figures 26, 27).

BIOLOGY.—Essentially unknown. Most specimens have been taken in depths between 55 and 73 meters; they have not been taken in the littoral habitat as have both *H. harpax* and *H. raphidea.* Specimens from Madagascar were taken on sand or muddy sand.

Harpiosquilla melanoura was taken along with *H. annandalei* at ANTON BRUUN Sta. 20 off the Mergui Archipelago.

DEVELOPMENT.—Unknown.

TYPES.—Division of Crustacea, National Museum of Natural History, Smithsonian Institution. Paratypes are in the Smithsonian Institution and the Museum National d'Histoire Naturelle, Paris.

TYPE-LOCALITY.—Banc de Pracel, western coast of Madagascar.

DISTRIBUTION.—Indo-West Pacific region, from Rose Bay, Port Jackson, New South Wales, Australia (Stephenson and McNeill, 1955, as *S. raphidea*); Mergui Archipelago; off Burma; and the Banc de Pracel, off the western coast of Madagascar (Manning, 1968b). It has not been recorded previously east of Madagascar.

FIGURE 24.—*Harpiosquilla melanoura* Manning. Male, TL 161 mm, Port Jackson, New South Wales: raptorial claw (propodus length 39.0 mm).

FIGURE 25.—*Harpiosquilla melanoura* Manning. Female, TL 151 mm, Mergui Archipelago: raptorial claw (propodus length 43.4 mm).

FIGURE 26.—*Harpiosquilla melanoura* Manning. Male, TL 161 mm, Port Jackson, New South Wales: posterior portion of body (telson width 30.0 mm).

FIGURE 27.—*Harpiosquilla melanoura* Manning. Female, TL 151 mm, Mergui Archipelago: posterior portion of body (telson width 27.6 mm).

6. *Harpiosquilla harpax* (de Haan, 1844)

FIGURES 28–38

Squilla harpax de Haan, 1844, atlas, pl. 51 (fig. 1); 1849, text, p. 222.—Tiwari and Biswas, 1952, p. 358, figs. 3b, d, f.—Barnard, 1955, p. 49—Alikunhi, 1959, p. 132, fig. 13 [larva].—Ingle, 1963, pp. 14, 18, figs. 9, 59.—Holthuis, 1964, p. 140 [listed].—Manning, 1968a, p. 121 [listed], fig. 3a.

Squilla raphidea.—Berthold, 1845, p. 47; 1847, p. 29.—White, 1847, p. 84.—Miers, 1880, p. 27 [part].—Bigelow, 1894, pp. 511 [key], 535.—de Man, 1898, p. 694 [part ?].—Tattersall, 1906, p. 166.—Balss, 1910, p. 8, fig. 2a.—Kemp, 1913, p. 88, pl. 7 (fig. 77) [part].—Parisi, 1922, p. 103.—Komai, 1927, p. 323.—Komai, Akatsuka, and Ikari, 1927, p. 295.—Komai and Ikari, 1929, p. 121.—Gravier, 1930, p. 525.—Chopra, 1934, p. 27 [part].—Serène, 1937, p. 68 [listed].—Komai, 1938, p. 268.—Suvatti, 1938, p. 52.—Chopra, 1939, p. 158.—Holthuis, 1941, p. 256 [part].—Liu, 1949, p. 43, pl. 6 (figs. 15–17).—Anonymous, 1949, p. 843, fig. 2421.—Barnard, 1950, p. 851, figs. 1c, g.—Suvatti, 1950, p. 132.—Dawydoff, 1952, p. 145.—Serène, 1953, p. 507; 1954, pp. 6, 8, 62, pl. 4 (figs. 1–6).—Millard and Harrison, 1954, p. 176 [listed].—Stephenson and McNeill, 1955, pp. 239 [part], 255 [key].—Day and Morgans, 1956, p. 306 [listed].—Utinomi, 1956, p. 91, pl. 46 (fig. 2) [color figure].—Yamaji, 1959, fig. on p. 68.—Utinomi, 1960, p. 114, pl. 57 (fig. 7) [color figure].—Chuang, 1961, pp. 181, 206, pl. 81 (fig. 4), lowest fig. on pl. 82.—Stephenson, 1962, p. 34.—Crosnier, 1965, p. 61 [listed]. [All not *Squilla raphidea* Fabricius.]

Squilla obsoleta White, 1847, p. 84 [nomen nudum; in synonymy].

Squilla Harpax.—Herklots, 1861, p. 152 [p. 39 on separate].

Squilla raphidea var.—Gravier, 1937, p. 186, figs. 8–10.

Squilla gilesi.—Boone, 1938, pp. 201, 203, pl. 71 [not *S. gilesi* Kemp].

Squilla raphidoea.—Serène, 1939, p. 349 [erroneous spelling].

?*Squilla* sp. [*Alima multispinus*].—Foxon, 1939, p. 258, fig. 2B [larva] [not *Erichthus multispinus* Claus, 1871].

?*Squilla* sp.—Gohar and Al-Kholy, 1957, p. 106 [larvae; part, several species mixed ?].

Squilla hanpax.—Alikunhi, 1959, p. 132 [discussion; erroneous spelling].

Harpiosquilla harpax.—Lee and Wu, 1966, p. 51, figs. 7A–F.—Manning, 1967, p. 103.—Holthuis, 1967, p. 15.—Chhapgar and Sane, 1968, p. 45 [key].—Manning, 1968b, pp. 14 [key], 15, fig. 4.—Tirmizi and Manning, 1968, p. 33, fig. 13.

?*Alima* stages of *Harpiosquilla raphidea-harpax* group.—Ingle and Della Croce, 1967, p. 6, figs. 19, 24 [larvae].

not *Harpiosquilla harpax*.—Manning, 1966, p. 87, fig. 1 [=*H. stephensoni*, new species].

MATERIAL.—1 ♂, 152.5 mm; Japan; lectotype of *S. harpax;* RMNH 28H.—1 ♂,175 mm; China or Japan; U.S.S. PALOS; SI Crust. 5146.—1 ♂, CL 20.2 mm; between Kobe and Yokahama, Japan; 34°06′15″N, 134°57′50″E; 40–37 fms; fine gray shell mud; ALBATROSS Sta. 4963; 27 August 1906; SI Crust. 76058.—1 ♂, 85 mm; Takao, Taiwan; F. Baker, col.; December 1914; SI Crust. 47935.—1 ♂, 109 mm; same; SI Crust. 47928.—1 ♂, 146 mm; Tungkang market, Taiwan; 40–50 fms; S. Lee and S. K. Wu; 5 March 1965; SI Crust. 113645.—1 ♀, 215 mm; Hong Kong; North Pacific Exploring Expedition; SI Crust. 2108.—1 ♂, 137 mm; Makung, Penghu Island, Pescadores Islands, China Sea; 19 April 1961; SI Crust. 124762.—1 ♂, 132 mm; Nhatrang Bay, Viet-Nam; DE LANESSAN, col.; 1930; SI Crust. 124721.—2 ♂ (1 broken), 132 mm; 2 ♀ (1 broken), 109 mm; Sandakan Fish Market, North Borneo; Chin Phui Kong, col.; 5 November 1956; AM P–14923.—1 broken ♀, CL 39.5 mm; off North East Island, near Groote Eylandt, western Gulf of Carpentaria, Northern Territory, Australia; 25 fms; CSIRO Prawn Survey; 4 September 1963; AM P–15508.—1 ♀, 248 mm; Tin Can Bay, near Gympie, Queensland, Australia; taken in net by C. Lea; 7 July 1952; AM P–12256.—1 broken ♂, CL 36.2 mm; Cape Flattery, Queensland, Australia; AM G–1792.—1 ♀, 225 mm; The Basin, Newcastle Harbour, New South Wales, Australia; from prawn trawl; A. A. Racek, col.; 27 May 1954; AM P–12512.—1 ♂, CL 29.6 mm; Hawkesbury River, N.S.W., Australia; hooked by line fisherman; March 1952; AM P–12230—1 broken ♂, CL 27.5 mm; Bobbin Head, near Jerusalem Bay, Hawkesbury River, N.S.W., Australia; taken from stomach of fish, flathead; May 1952; AM P–12229.—1 ♂, 188 mm; Jerusalem Bay, Hawkesbury River, N.S.W., Australia; hooked by line fisherman; 18 May 1952; SI Crust. 124765.—1 ♀, 143 mm; Jerusalem Bay, Hawkesbury River, near Sydney, N.S.W., Australia; R. Woodger, col.; AM P–15399.—1 ♀, 180 mm; Jerusalem Bay, Hawkesbury River, near Sydney, N.S.W., Australia; handline from 30 ft of water on hook baited with small fish; A. B. Iverach, col.; 24 January 1965; AM P–15402.—1 ♀, 175 mm; Cowan Creek, Hawkesbury River, N.S.W., Australia; 1 February 1953; SI Crust 124766.—1 ♂, 165 mm; same, from stomach of 71 lb flathead fish; March 1960; AM P–13324.—1 ♀, 190 mm, same; handline and baited hook; L. Kelly, col.; 23 April 1960; AM P–15400.—1 ♀, 185 mm; same; handline and baited hook; A Leslie, col.; 18 March 1961; AM P–15401.—1 ♀, 195 mm; same; handline from 15 ft water on small hook baited with prawn; 26 April 1965; AM P–15403.—1 ♂, 110 mm; Lem Sing, Thailand; 10 January 1924; SI Crust. 124761.—1 ♀, 168 mm; Tachalom, Gulf of Siam; trap; Hugh M. Smith; 21 July 1923; SI Crust. 69533.—1 ♀, 157 mm; South Kang Kradan, Thailand; Hugh M. Smith; 1923; SI Crust. 69534.—1 ♀, 153 mm; beach north of Singora, Thailand; Hugh M. Smith; 5 October 1923; SI Crust. 69535.—1 ♂, 87 mm; Bay of Bengal; 15°04′N, 95°51′E; 29—33 m; ANTON BRUUN Cruise 1, Sta. 41A; IIOE; 31 March 1963; SI Crust. 125356.—1 ♀, 153 mm; Sandheads, mouth of River Hooghly [Hughli], India; LADY FRASER; SI Crust. 119312.—1 ♂, 120 mm; 2 ♀, 129–173 mm; India; 17°54–57′N, 72°23–27′E; 46–55 m; green mud, shells; ANTON BRUUN Cruise 4B, Sta. 201A; IIOE; 13 November 1963; SI Crust. 125352.—2 ♂, 71–146 mm; 2 ♀, 122–164 mm; off Bombay, India; 18°47.3–49′N, 72°36–38′E; 12.5–14 fms; M.V.F. JANJIRA; Field No. 9682; IIOE; 12 May 1964; SI Crust. 125354.—7 ♂, 72–120 mm; 5 ♀, 64–140 mm; India; 20°30′N, 70°50–54′E; 33 m; brown sticky mud; ANTON BRUUN Cruise 4B, Sta 204A; IIOE; 15 November 1963; SI Crust. 125355.—1 ♀, 165 mm; northwestern India; 22°52–54′N, 68°34–36′E; 15 m; soft mud; ANTON BRUUN Cruise 4B, Sta. 223A; IIOE; 19 November 1963; SI Crust. 125353.—1 ♀, 148 mm; Gulf of Oman; 26°10–13′N, 57°02′E; 55–64 m; green mud; ANTON BRUUN Cruise 4B, Sta. 256A; IIOE; 30 November 1963; SI Crust. 125351.—5 ♂, 139–166 mm; 8 ♀, 134–185 mm (in 2 lots); Archico Bay, south of Massawa, Ethiopia, Red Sea; Israel South Red Sea Exped., Sta. E62/4118; 8 April 1962; SI Crust. 124763, 124764.

DIAGNOSIS.—Size moderate to large, TL to 248 mm; antennular peduncle usually shorter than carapace; corneal indices ranging between 251 and 388 (Table 1); rostral plate longer than broad (Figure 31), with slender anterior projection; carapace with median carina; opposable margin of propodus of claw with smaller spines and denticles between largest spines; dactylus of claw with 8 teeth, outer margin of dactylus with prominent angular projection in adult males;

fifth thoracic somite (Figure 32) rounded laterally; posterior 3 thoracic somites with submedian and intermediate carinae, none armed posteriorly; ventral keel of eighth thoracic somite rounded; abdomen with submedian carinae on all somites, abdominal carinae spined as follows: submedian 6, intermediate (1) 2–6, lateral 1–6, marginal 1–5; denticles 4–6, 10–12 (14), 1; marginal carina of telson more than twice as long as carina of lateral tooth; postanal keel extending about halfway between anus and posterior margin; distal segment of uropodal exopod with inner half black.

Color.—In preservative, black transverse line on dorsum between antennular and ophthalmic somites; antennal scale with diffuse dark pigment, concentrated along anterior margin; carinae, grooves, and anterior and posterior margin of carapace dark, pair of dark spots also present on lateral plates of carapace at level of cervical groove; display patch on dorsal surface of merus yellow, with proximal oval dark patch and distal dark spot; last 3 thoracic and first 5 abdominal somites with dark posterior line; telson with pair of dark circles or square spots on anterior dorsal surface; distal segment of uropodal exopod with diffuse dark chromatophores on inner half, distal third of proximal segment also dark; distal half of endopod dark, with light midrib in some specimens; apices of teeth of uropods and telson yellow in some specimens. The overall color pattern is shown in Figure 28.

The notes on color in life given below from Komai (1927, p. 323) and Utinomi (1956, 1960) may refer to this species but may also refer to *H. japonica,* new species.

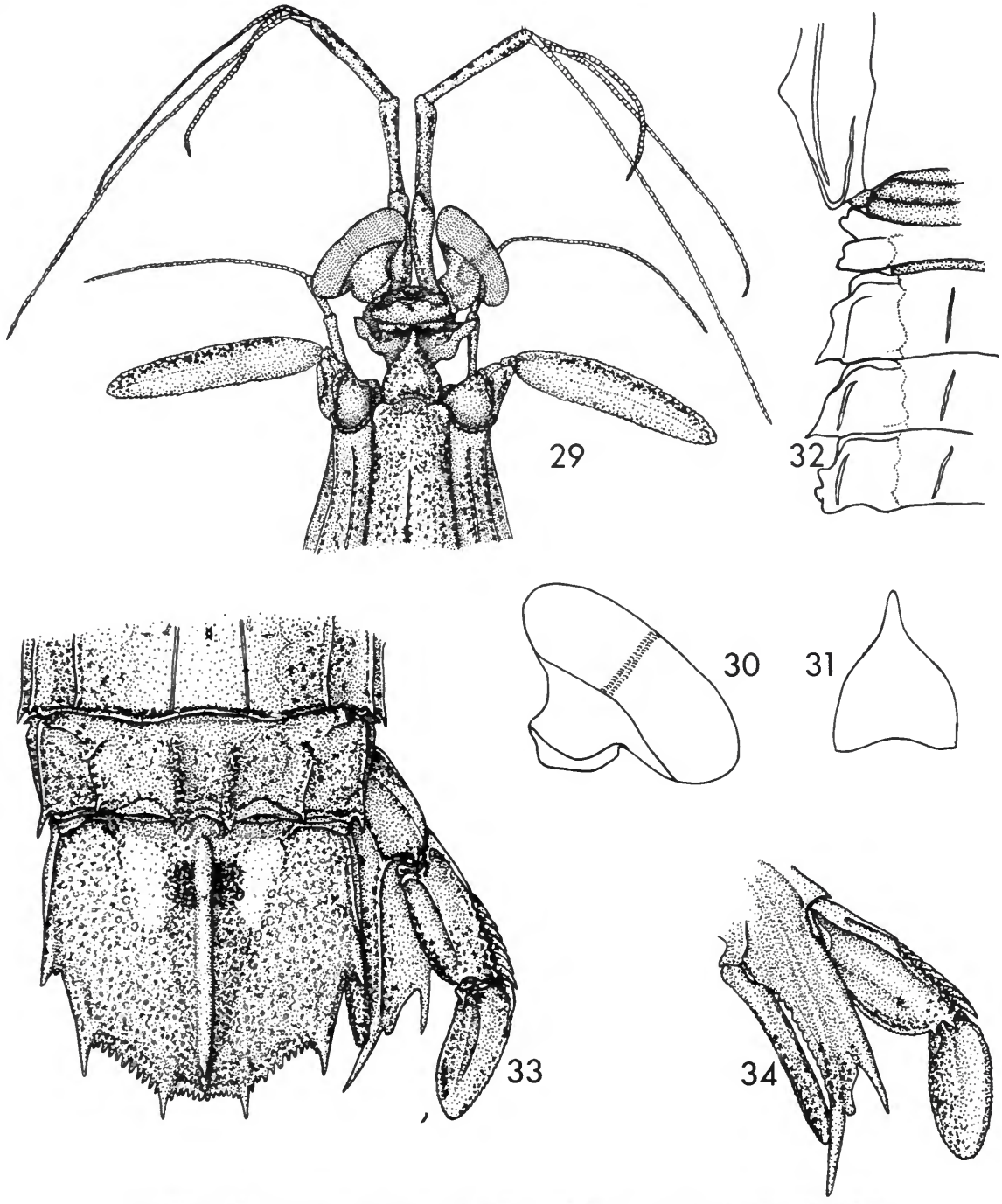
> When fresh, the entire surface is pale and slightly ochraceous, besprinkled with minute dark spots. A pinkish color is found on the carapace, raptorial limbs and on the thoracic and abdominal somites. A conspicuous round patch of chestnut-brown color occurs on either side of the base of the middorsal carina of the telson.

According to Utinomi (1956) this species is pinkish, setae of scale and uropod yellow, telson with pair of proximal red spots. He (1960, p. 114) also reports:

> Antennal scale blue, setae yellow; propodus yellow distally, apices of teeth of chela yellow; submedian carinae of first to fifth abdominal somites and sixth to eighth thoracic somites yellow, lateral carinae on body with more red; submedian carinae of sixth abdominal somite green; median carina of telson and pits green; carinae of marginal teeth green, apices yellow; most of uropod yellow.

Tirmizi and Manning (1968, p. 33) reported the following color pattern in fresh specimens from Karachi, West Pakistan:

Figure 28.—*Harpiosquilla harpax* (de Haan). Male, TL 188 mm, Jerusalem Bay, New South Wales: dorsal view.



FIGURES 29–34.—*Harpiosquilla harpax* (de Haan). Female, TL 118 mm, Ambaro Bay, Madagascar: 29, anterior portion of body; 30, outline of eye; 31, outline of rostral plate; 32, outline of lateral processes of exposed thoracic somites; 33, last two abdominal somites, telson, and uropod; 34, uropod, ventral view. (Setae omitted; from Manning, 1968b).

. . . eyestalks bright yellow; antennal peduncle and scale with pink patches; carinae of carapace lined with dark spots; merus and carpus of raptorial claw with pink patches; posterior margin of each of thoracic and abdominal somites lined with black spots; lateral portions of abdominal somites pink; sixth abdominal somite pink between submedian carinae; spines on abdomen, telson, and uropod yellow; telson with grey pits and carinae except for red median carina; proximal submedian patches of telson maroon (black in preservative); base of uropod pink.

SIZE.—Males, TL 71–188 mm; females, TL 64–248 mm. Males ranging in TL between 80 and 195 mm and females TL 112 to 215 mm have been recorded in the literature (size data from corroborated distribution records only).

Other measurements of male lectotype, TL 152.5 mm: carapace length 29.1; cornea width 9.2; antennular peduncle length 28.1; rostral plate length 5.0, width 4.8; raptorial propodus length 38.4; fifth abdominal somite width 30.6; telson length 29.4, width 26.2.

DISCUSSION.—*Harpiosquilla harpax,* the commonest and most widely distributed species of the genus, can be distinguished with ease from the other species. The apical median projection of the rostral plate at once separates it from *H. annandalei, H. japonica,* new species, and *H. stephensoni,* new species; in all of those species the rostral plate is blunt apically, either broadly rounded or obtusely rounded. *Harpiosquilla harpax* is a smaller species than *H. raphidea,* and the carinae on the body are not nearly so well developed as in that species; in *H. harpax* the intermediate carinae of the last three thoracic somites are unarmed whereas they are provided with spines in *H. raphidea,* and the lateral process of the fifth thoracic somite is rounded in *H. harpax,* spined laterally in *H. raphidea.* The faint submedian carinae on the abdomen will distinguish *H. harpax* from both *H. indica,* new species, and *H. melanoura;* the latter species lacks the median carina on the carapace as well. In *H. indica,* the intermediate carinae of the first and second abdominal somites are unarmed; the carinae of the second abdominal somite are always armed in adults of *H. harpax.*

The color pattern of *H. harpax,* in preserved specimens, is very similar to that of both *H. indica* and *H. stephensoni,* but very distinct from those of *H. annandalei* and *H. melanoura.* In *H. harpax,* the inner half of the distal segment of the uropodal exopod is covered with diffuse dark pigment. In *H. annandalei* that segment is black with a white midrib and in *H. melanoura* it is entirely black. The color pattern of the uropod is not nearly so well marked in *H. raphidea* as in any of these species. The color pattern of *H. japonica,* is not known.

The shape and length of the marginal carinae of the telson are also distinctive in *H. harpax* which has a slender marginal carina over twice as long as the carina of the intermediate tooth. In *H. melanoura* the marginal carina is three times as long as the intermediate, and in the remainder of the species it is less than twice as long.

Harpiosquilla harpax is not a small species but it apparently does not get nearly so large as do either *H. raphidea* or *H. stephensoni.* The maximum observed size in *H. harpax* is 248 mm in contrast with 335 mm for *H. raphidea* and 315 mm for *H. stephensoni.*

The intermediate carinae of the first abdominal somite were armed in only three of these specimens, a female from Luzon, a female from India, and a male from Viet-Nam. In addition, the small specimen (CL 20.2 mm) from Japan lacked spines on the intermediate carinae of the first two abdominal somites. All but one of the specimens from the collections of the Australian Museum had both intermediate carinae of the first abdominal somite unarmed posteriorly. In all other respects the specimens from Australia agree well with the remainder of the specimens from other localities available for study.

Holthuis (1967) noted that the anterior projection of the rostral plate was a variable feature in his specimens from the Red Sea. There is also some variation in relative length of the anterior projection in specimens from Australia. The plate in *H. harpax,* however, never terminates so bluntly as it does in *H. annandalei, H. stephensoni,* and *H. japonica.*

All available specimens of *H. harpax* were examined to determine the extent of variation of the corneal indices, if any. Although the samples from any area were small, no obvious variation by sex, size, or location could be detected. The eye is remarkably uniform in size and shape over a wide geographic area. Corneal indices of all species are summarized in Table 1.

All specimens examined by me had eight teeth on the dactylus of the claw. Parisi (1922) recorded one specimen from Suruga Gulf, Japan, with but seven teeth on one claw.

FIGURE 35.—*Harpiosquilla harpax* (de Haan). Male, TL 188 mm. Jerusalem Bay, New South Wales: raptorial claw (propodus length 42.9 mm).

FIGURE 36.—*Harpiosquilla harpax* (de Haan). Female, TL 175 mm, Cowan Creek, New South Wales: raptorial claw (propodus length 45.9 mm).

It has been pointed out already that Alikunhi's (1967) excellent account of growth is probably based on both *H. harpax* and *H. raphidea.* Certainly some of the observations made by Alikunhi on changes with age apply to this species as well as to *H. raphidea.*

SYNONYMY.—It has been very difficult to determine which of the early records of *S. raphidea* actually belonged to *H. harpax.* Several criteria have been used but only a few records could be checked so most of the references referred herein to *H. harpax* require verification.

Geography has been the basis for assigning some records of *H. harpax* rather than to *H. raphidea.* The latter species is not known to occur with certainty as far north as China or Japan, as far south as Australia, or as far west as South Africa. Most locality records from Japan for *H. raphidea* probably are referable to *H. harpax,* but some may be referable to *H. japonica,* new species. Most records from Japan require verification.

In some cases I have examined material previously recorded in the literature, although only in the case of the collections from the Australian Museum and the Smithsonian Institution have I been able to examine the bulk of the collection. Some of the material recorded by the following authors has been examined: de Haan, 1844, 1849; Holthuis, 1941, 1967; Lee and Wu, 1966; Boone, 1938; Gravier, 1930; Millard and Harrison, 1954; Stephenson and McNeill, 1955. I have accepted the records of Tiwari and Biswas (1952) and those of Kemp (1913) and Chopra (1934) which they corroborated. The records of Ingle (1963) and the earlier records corrected by him have also been assigned to *H. harpax.*

The numerous records from Viet-Nam by Gravier (1930), Serène (1937, 1939, 1953, 1954) and Dawydoff (1952) are assigned here for two reasons. Their accounts concur with my observations on *H. harpax* rather than *H. raphidea,* and we have no authenticated records of *H. raphidea* from east of Borneo and north of Thailand. Serène's (1954) observations on sexual dimorphism agree well with what I have observed in *H. harpax.* All of these authors, however, could have been dealing with both species.

Gravier (1937) recorded three specimens from the Baie d'Along [Tonkin], Viet-Nam, as *S. raphidea* var.

His illustrations clearly show that his specimens are referable to *H. harpax,* for the thorax and telson of the illustrated specimen are typical of that species.

De Man (1898) noted that a small male, TL 11 cm, from the Java Sea had poorly developed submedian carinae on the abdomen and lacked the spine on the fifth thoracic somite; he attributed these features to individual aberration. He was almost certainly dealing with *H. harpax* in this case; he may also have examined some *H. raphidea.*

Gravier (1937) also commented that another specimen collected by Dawydoff differed from his material in several features. I cannot determine from his account the distinguishing features of Dawydoff's material.

Tattersall (1906) reported that a male from Ceylon had an obtuse lateral process on the fifth thoracic somite; he, too, was probably dealing with *H. harpax.*

Judging from the size of specimens reported from Queensland, Australia, TL to 222 mm, some of the specimens identified by Stephenson (1952, 1953) as *S. raphidea* may actually be referable to *H. stephensoni,* new species, and *H. harpax.*

Suvatti's records of *S. raphidea* from Thailand (1938, 1950) are apparently based on collections made there by Hugh M. Smith. Material from the localities given by Suvatti is in the Smithsonian Instituion and is clearly referable to *H. harpax.* Although Smith also collected *H. raphidea* in Thailand, those specimens were not recorded by Suvatti.

The specimens from Singapore reported by Boone (1938) as *S. gilesi* are almost certainly *H. harpax;* although a lateral spine is shown on the fifth thoracic somite by Boone (op. cit., pl. 72), the specimens actually lack lateral spines. It seems likely that the ventral spines on that somite are exaggerated in the figure. Boone's records have been corrected by both Holthuis (1941) and Manning (1967).

The specimen figured by Chuang (1961) on his plate 82 shows no trace of submedian carinae on the abdomen or of a lateral spine on the fifth thoracic somite. For these reasons I have assigned his records to *H. harpax,* which has very low submedian carinae on the abdomen. Chuang (1961, p. 181) commented on the presence of middorsal carinae on the last two thoracic somites as a distinguishing feature of *S. raphidea;* none of the species of *Harpiosquilla* are ornamented with middorsal carinae on either the thorax or abdomen.

FIGURE 37.—*Harpiosquilla harpax* (de Haan). Male, TL 188 mm, Jerusalem Bay, New South Wales: posterior portion of body (telson width 33.9 mm).

FIGURE 38.—*Harpiosquilla harpax* (de Haan). Female, TL 175 mm, Cowan Creek, New South Wales: posterior portion of body (telson width 32.2 mm).

Liu (1949), on the other hand, shows strong submedian carinae on the thorax and abdomen and short marginal carinae on the telson, but mentions that the fifth thoracic somite has no lateral process; an apical projection is shown on the rostral plate. It seems likely that the submedian carinae of the body and the carinae of the telson were exaggerated in the illustration and that he was dealing with *H. harpax.*

SEXUAL DIMORPHISM.—Males of *H. harpax* exhibit the secondary sexual characters also found in most other species of *Harpiosquilla.* The obtuse prominence on the outer margin of the claw in adult males can be observed at a size of about 120 mm TL (CL ca. 22 mm) (Figure 35). It becomes larger and more angular with increasing age. It is not so well developed in *H. harpax* at TL 150 mm as it is in *H. indica,* new species. The bases of the second through the sixth dactylar teeth are inflated, as illustrated by Serène (1954, pl. 4, fig. 4). The submedian carinae of the sixth abdominal somite and the median carina of the telson may be inflated in adults of both sexes; often the median carina of the telson is more inflated in females than in males (Figures 37, 38). The carinae of the marginal teeth of the telson are not markedly inflated in adults of either sex.

BIOLOGY.—As is the case in the other species of *Harpiosquilla,* we can glean relatively little information on the biology of *H. harpax* from the literature and from specimen-associated data. It is a widely distributed species in the Indo-West Pacific region, and it occurs in shallow water, between 2 and 93 meters. Chuang (1961) recorded it from the sublittoral zone in Singapore. It apparently has a preference for mud bottom, for recorded bottom types include green mud, shell; brown sand; grey sand; brown sticky mud; soft mud; green mud; muddy sand; and sandy shore. It was taken together with *H. annandalei* in 55–64 meters in the Gulf of Oman by the ANTON BRUUN; in general, it occurs in shallower water than does *H. annandalei.*

Harpiosquilla harpax has been recorded from fish markets from three areas, the Tungkang Market, Taiwan (Lee and Wu, 1966), the Sandakan Fish Market, Borneo, and Fish Harbour, Karachi, West Pakistan (Tirmizi and Manning, 1968). In Pakistan, at least, it is not sought for food but is brought to shore along with the trash from commercial shrimping operations.

The specimens from Australia were taken in prawn nets, on hook and line by fishermen, and from the stomach of a fish known locally as flathead. It may enter water of lowered salinity, for it seems to be abundant in different sections of the Hawkesbury River, New South Wales.

DEVELOPMENT.—The larvae of *H. harpax* are not known with certainty. Foxon (1939) reported larvae from the Red Sea, the northern Arabian Sea, and the Gulf of Oman; she noted that the larvae were of two types, with one (typical form) or two (atypical form) laterally directed spines on the lateral margin of the carapace. Both forms occurred in all three areas. She suggested that these might be the larvae of *raphidea* and *annandalei,* and pointed out the similarity of the larva reported by her to *Erichthus multispinus* Claus.

In his discussion of the development of *raphidea,* Alikunhi (1952, p. 269) noted that "The atypical form of *Alima multispinous* described by Foxon (1939) also shows close similarity to the final pelagic larva of *S. raphidea,*" differing in having one rather than two laterally directed spinules on the carapace. Alikunhi further pointed out that the typical form reported by Foxon differed from known *Harpiosquilla* larvae in having four free teeth on the dactylus of the claw.

Alikunhi then suggested that the atypical form might be identified with *raphidea* whereas the typical form might be the larva of *annandalei.* Ingle and Della Croce (1967, p. 67) reexamined Foxon's specimens and stated, "The specimens identified by Foxon (1939, p. 258) as atypical forms of *Alima multispinosa* (Claus) agree with Alikunhi's figures and description of late *S. raphidea* larvae."

Inasmuch as *H. raphidea* is not known to occur in the Red Sea and *H. harpax* is the only *Harpiosquilla* which occurs in the Red Sea, northern Arabian Sea, and the Gulf of Oman, it seems likely that Foxon's atypical larva may be the larva of *H. harpax.* Whether or not the other larva reported by Foxon is even identifiable with *Harpiosquilla* remains to be seen.

Some of the larval forms from the Red Sea identified as *Squilla* sp. by Gohar and Al-Kholy (1957) may be identifiable with *H. harpax* (see their figs. 5–7, pl. XII). Judging from the illustrations, their *Squilla* sp. includes the larvae of more than one species.

Alikunhi (1959) recorded young larvae of *harpax* from off the Mahanadi Estuary, India.

The larval stages of *Harpiosquilla* reported from the Mozambique Channel by Ingle and Della Croce (1967) may be referable to *H. harpax* or *H. melanoura,* both of which occur as adults off Madagascar, or to *H. raphidea,* which occurs on the east coast of Africa.

The alima larva from Japan figured by Yamaji (1959) adjacent to his figure of *raphidea* does not resemble the larva of *Harpiosquilla.*

Some of the observations made by Alikunhi (1967) on *Harpiosquilla* postlarvae may apply to *H. harpax* as well as to *H. raphidea.*

TYPE.—The lectotype and paralectotypes are in the Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands.

TYPE-LOCALITY.—Japan.

DISTRIBUTION.—Indo-West Pacific region, from Japan and Australia in the Pacific to the Red Sea and South Africa in the Indian Ocean. Shallow water to 93 m. The following records in the literature are probably correct: JAPAN: No specific locality (de Haan, 1844, 1849; Herklots, 1861; Holthuis, 1941; Manning, 1968b).—TAIWAN: Tungkang Fish Market, 40–50 fms (Lee and Wu, 1966).—CHINA: Hongkong (Bigelow, 1894; Kemp, 1913; Tiwari and Biswas, 1952).—VIET-NAM: Baie d'Along [Tonkin] (Gravier, 1937); Baie Nhatrang, 50 m (Gravier, 1930).—PHILIPPPINE ISLANDS: No specific locality (Miers, 1880; Ingle, 1963).—MALAYSIA: Singapore (Boone, 1938; Tiwari and Biswas, 1952; Manning, 1967); Siglap, Singapore (Chuang, 1961); Morib (Chuang, 1961).—INDONESIA: Java Sea, between Singapore and Surabaya [Surabaja] (de Man, 1898).—AUSTRALIA (all Stephenson and McNeill, 1955): Cape Flattery and Tin Can Bay, Queensland; Cowan Creek, Jerusalem Bay, and Hawk River, New South Wales.—THAILAND: Tachalom and Gulf of Siam, north of Singora (Suvatti, 1938, 1950).—ANDAMAN ISLANDS: Port Blair (Tiwari and Biswas, 1952).—INDIAN OCEAN: (White, 1847; Miers, 1880; Ingle, 1963).—INDIA: mouth of River Hughli [Hooghly, including Sandheads] (Kemp, 1913; Tiwari and Biswas, 1952); off Madras coast (Kemp, 1913); Madras Presidency (Tiwari and Biswas, 1952); Bombay (Chhapgar and Sane, 1968); off Bombay, 20–25 fms (Tiwari and Biswas, 1952).—CEYLON: southwest part of Palk Bay, off Adam's Bridge and Rámeswaram Island, 7–9 fms (Tattersall, 1906).—WEST PAKISTAN: Karachi (Tirmizi and Manning, 1968).—GULF OF OMAN: (Chopra, 1939; Ingle, 1963).—RED SEA: southern Red Sea (Ingle, 1963); Archico Bay, south of Massawa, Ethiopia, 8–17 fms (Holthuis, 1967).—ZANZIBAR: (Miers, 1880; Ingle, 1963).—MADAGASCAR: Ambaro Bay, Nosy Bé, 2–5 m (Manning, 1968b); Baie de Narendry, 6 m (Manning, 1968b).—SOUTH AFRICA: Richards Bay (Millard and Harrison, 1954); Durban (Barnard, 1950, 1955; Day and Morgans, 1956).

The following records, listed in the literature as *raphidea,* may be referable to *H. harpax;* records for Japan might be dealing with *H. japonica,* new species, and those from Australia may be referable to *H. stephensoni,* new species. JAPAN: No specific locality (Anonymous, 1949; Utinomi, 1956, 1960; Yamaji, 1959); Suruga Gulf (Kemp, 1913; Parisi, 1922); Kii Peninsula (Komai, Akatsuka, and Ikari, 1927); Seto, Kii Province (Komai, 1927, 1938); Tanabe Bay, Kii Peninsula (Komai and Ikari, 1929); Tanabe (Komai, 1938); Wakanoura (Komai, 1938); Kasiwazima, Tosa Province (Komai, 1927); Misaki (Komai, 1927); Nagasaki (Balss, 1910; Parisi, 1922; Komai, 1927).—TAIWAN: northern Formosa (Komai, 1927); Takao (Balss, 1910).—CHINA: no specific locality (Berthold, 1845, 1847); Hongkong (Liu, 1949).—VIET-NAM: Indo-China (Gravier, 1930; Serène, 1937, 1953); Baie de Cauda, 15–25 m (Serène, 1954); Baie de Nhatrang, 8–12 m (Serène, 1939); Baie d'Along [Tonkin] (Dawydoff, 1952); Baie de Tourane, 25–30 m; Embouchure du Bassac; Cap Saint Jacques; Baie de Hone Coké, entrée de Port Dayot; Poulo Condore Islands (all Gravier, 1930).—SUBLICHES OSTASIENS: (Balss, 1910).—AUSTRALIA: Wyndham, Western Australia (Stephenson, 1962).—INDIA: Sandheads (Chopra, 1934).—MADAGASCAR: (Crosnier, 1965).

Larvae which may prove to be the larvae of *H. harpax* have been reported from the Red Sea by Foxon (1939) and Gohar and Al-Kholy (1957), the northern Arabian Sea and Gulf of Oman by Foxon (1939), the Mozambique Channel by Ingle and Della Croce (1967), and perhaps, from the east coast of India by Alikunhi (1952, 1959). See also the section on larvae for both *H. harpax* (p. 25) and *H. raphidea* (p. 9).

7. *Harpiosquilla indica,* new species

FIGURES 39–43

HOLOTYPE.—1 ♂, 150 mm; 10 miles due south of Mandapam Camp, South India; 12 fms; otter trawl; L. P. Woods on Norwegian trawler M-2; Sta. LW-20 (GA 64-7); 11°0E; 14 February 1964; SI Crust. 125717.

DIAGNOSIS.—Size moderate, male with adult characters at TL 150 mm; antennular peduncle shorter than carapace; corneal index 290; rostral plate (Figure 40) longer than broad, lateral margins tapering to

slender median projection; carapace with median carina; upper margin of propodus of claw with smaller spines and denticles between largest spines; dactylus of claw with 9 teeth, outer margin with prominent angular projection in adult male; fifth thoracic somite rounded laterally (Figure 42); posterior 3 thoracic somites lacking submedian carinae; intermediate carinae of thoracic somites unarmed; ventral keel of eighth thoracic somite rounded; first to fifth abdominal somites lacking submedian carinae, abdominal carinae spined as follows: submedian 6, intermediate 3–6, lateral 1–6, marginal 1–5; denticles 5, 11, 1; marginal carina of telson not more than 1.5 times as long as carina of lateral tooth; postanal keel short, not extending halfway between anus and posterior margin; at most inner half of distal segment of uropodal exopod dark.

COLOR.—Inner and outer surfaces of antennular peduncles lined with dark pigment; antennal scale outlined with dark chromatophores; dark transverse bar present dorsally between antennular and ophthalmic somites; rostral plate outlined with dark pigment, basal portion of plate with oval ring of dark chromatophores; margins, carinae, and grooves of carapace outlined with dark pigment; meral depression of claw with proximal and distal dark spots; posterior 3 thoracic

FIGURE 39.—*Harpiosquilla indica,* new species. Male holotype, TL 150 mm: dorsal view.

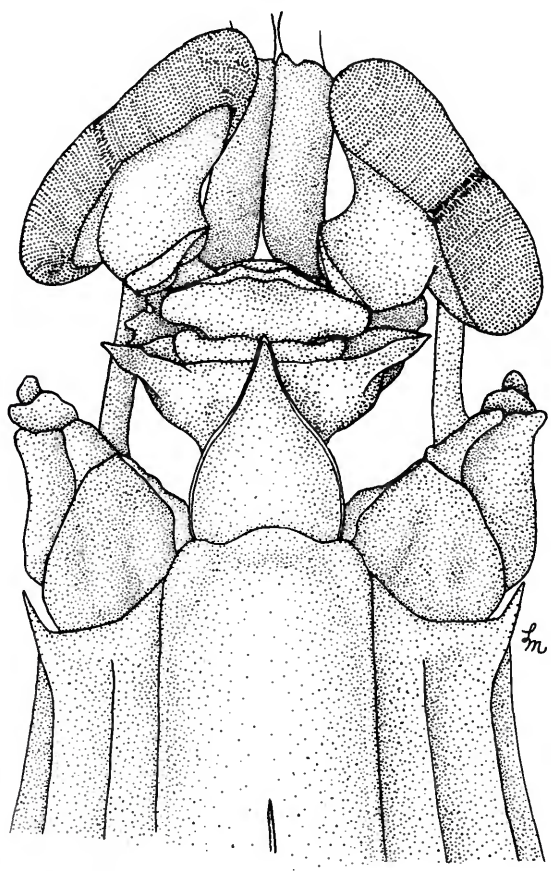


FIGURE 40.—*Harpiosquilla indica,* new species. Male holotype, TL 150 mm: anterior portion of carapace.

and all abdominal somites with dark posterior line and intermediate carinae lined with dark pigment; submedian area of thoracic and abdominal somites with diffuse dark pigment; telson with marginal carinae and dorsal pits darker than remaining surface; ventral surface of telson with bases of teeth and submedian distal area darker than remainder of surface; anterior edge of basal segment and proximal segment of uropodal exopod with diffuse dark spot; distal fourth of proximal segment of uropodal exopod with diffuse dark pigment, inner half of distal segment black; distal half of endopod dark with apex lighter along midline. The overall color pattern is shown in Figure 39.

SIZE.—Only specimen known, the male holotype, TL 150 mm. Other measurements (in mm): carapace length 30.5; cornea width 10.5; antennular peduncle length 27.0; rostral plate length 6.8, width 5.4; raptorial propodus length 39.4; fifth abdominal somite width 33.0; telson length 29.6, width 28.0.

DISCUSSION.—*Harpiosquilla indica,* new species, most closely resembles *H. melanoura,* differing from the latter species as follows: (1) there are nine teeth on the dactylus of the claw rather than eight; (2) there is a well-developed median carina on the carapace; (3) only the inner half of the distal segment of the uropodal exopod is black; and (4) the marginal carina of the telson is comparatively shorter, being not more than one and one-half times rather than nearly three times as long as the carina of the lateral tooth.

The lack of submedian carinae on the posterior three thoracic and anterior five abdominal somites, the unarmed intermediate carinae anterior to the third abdominal somite, and the shorter marginal carina of the telson will distinguish *H. indica* from *H. harpax,* which it otherwise closely resembles. In *H. indica* the projection on the outer margin of the dactylus of the male is much more angular than that found in *H. harpax,* and the median carina of the telson in the holotype of *H. indica* is more inflated than in males of either *H. harpax* or *H. melanoura* of similar size.

Harpiosquilla japonica differs from *H. indica* in lacking the median projection on the rostral plate and in having submedian carinae on the posterior three thoracic and all six abdominal somites.

The eye of the holotype of *H. indica* is similar in size to that of *H. melanoura* and noticeably larger than

FIGURE 41.—*Harpiosquilla indica,* new species. Male holotype, TL 150 mm: raptorial claw (propodus length 39.4 mm).

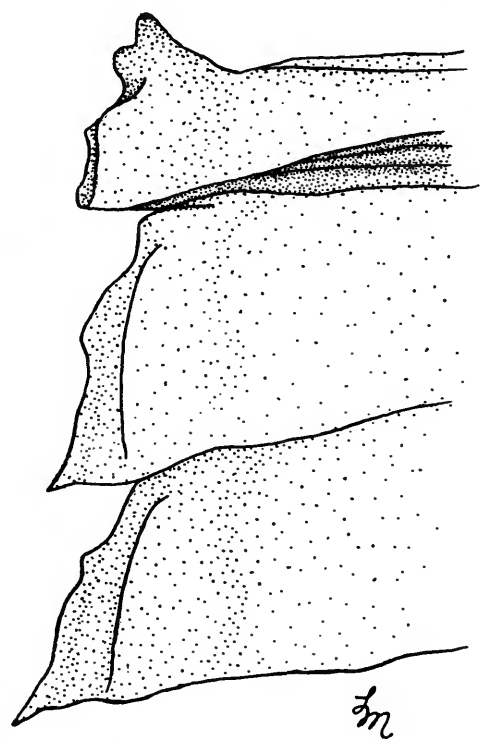


FIGURE 42.—*Harpiosquilla indica,* new species. Male holotype, TL 150 mm: lateral processes of fifth, sixth, and seventh thoracic somites.

FIGURE 43.—*Harpiosquilla indica,* new species. Male holotype, TL 150 mm: posterior portion of body (telson width 28.0 mm).

the eyes of either *H. stephensoni* or *H. harpax* of similar size.

The color pattern of *H. indica* is very similar to that of *H. harpax*. The holotype of *H. indica* lacks the paired submedian spots on the telson but that may be an artifact of preservation, and it also lacks the concentration of dark chromatophores on the anterolateral margin of the antennal scale which is characteristic of *H. harpax*.

SEXUAL DIMORPHISM.—The holotype has a pronounced projection on the dactylus of the claw (Figure 41) which is much more angular than that found in *H. harpax*. The basal inflation of the teeth of the claw, swollen submedian carinae of the sixth abdominal somite, and inflated median carina of the telson (Figure 43) are well developed in the single male specimen available for study.

BIOLOGY.—Unknown.

DEVELOPMENT.—Unknown.

TYPE.—The holotype is in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution.

TYPE-LOCALITY.—Ten miles due south of Mandapam Camp, South India, in 12 fathoms.

NAME.—The name refers to the occurrence of the species off India.

DISTRIBUTION.—Known only from the type-locality.

General Remarks

The species of *Harpiosquilla* are large squillids which are found in relatively shallow water throughout most of the Indo-West Pacific region. All species occur on the shelf; the maximum depth recorded is 206 meters for *H. annandalei*. That species, which has been taken in depths between 15 and 206 meters, also shows the widest depth range. *H. melanoura* has been taken in depths between 55 and 73 meters. The remaining species, *H. harpax, H. indica,* new species, *H. japonica,* new species, *H. stephensoni,* new species, and *H. raphidea,* generally occur in depths of 51 meters or less, although *H. harpax* has been collected as deep as 91 meters. At least three species, *H. harpax, H. stephensoni,* and *H. raphidea,* may occur in the sublittoral zone.

Judging from the limited information available both in the literature and from data associated with specimens reported here, the species of *Harpiosquilla* all prefer a soft, level bottom; they do not appear to be associated with coral reefs, or with rough, rocky bottom. At least one species, *H. raphidea,* is tolerant of lowered salinities.

The genus is not known to occur in Oceania. This may be a result of the paucity of collections from that area but more likely reflects the lack of suitable habitat there.

In a study of certain penaeid shrimps from the Indo-Malayan area, Hall (1962) commented on the existence of an apparent distributional barrier in the Malacca Straits. On the basis of this he cast suspicion on the validity of all littoral penaeid species reported to range throughout the Indo-West Pacific region. This does not seem to be true in *Harpiosquilla,* for four of the seven known species occur on both sides of the Indo-Malayan area, and two of these four species have broad distributional patterns in the Indo-West Pacific region. *H. harpax,* for example, extends from Japan to Australia in the western Pacific, and from there westward to the Red Sea and South Africa. *H. annandalei* has a similar distribution pattern, based on many fewer samples, but it does not occur in Australia and has not been recorded with certainty west or south of the Gulf of Oman. *H. raphidea* is known to occur from Borneo and Thailand to India, West Pakistan, and East Africa; it is not known with certainty to occur north of Borneo and Thailand in the Pacific and there are no apparent reasons for its relatively limited distribution in the western Pacific or its absence in Aus-

tralian waters. *H. melanoura* occurs in New South Wales, Australia, the Andaman Sea, and Madagascar.

The remaining species of *Harpiosquilla* may be indigenous to the areas from which they are now known. *H. indica,* new species, is known only from the type locality off southern India, *H. japonica,* new species, only from Japan, and *H. stephensoni,* new species, from the Northern Territory and Queensland, Australia. The latter two species are very similar and possibly represent the terminal portions of a more widely distributed ancestral stock. Among the stomatopods, a similar Japan-Australia link is shown by two species of *Heterosquilla, H. latifrons* from Japan and *H. brazieri* from Australia (Manning, 1966).

Within Australia the two most abundant species, *H. harpax* and *H. stephensoni,* have an interesting distributional patern. *H. stephensoni* is known with certainty from Darwin Harbour, Northern Territory to Port Curtis, Queensland; i.e., it is known only from the tropical waters of the eastern and northeastern coast on the Solanderian Province (Knox, 1963). If, as I have assumed, Stephenson's (1952, 1953) records for *Squilla raphidea* prove to be based on *H. stephensoni* rather than *H. harpax,* its distribution on the eastern Australian coast will be extended to Southport, Queensland, in the northern edge of the Peronian Province. *H. harpax,* however, extends from the Gulf of Carpentaria, on the Queensland side, south to the vicinity of Sydney in the cooler Peronian Province, is much more abundant in the southern portion of its range. It is nevertheless surprising to find *H. harpax,* the most abundant species of the genus, all of which otherwise are tropical, in the cooler, warm-temperate environs of Sydney. Perhaps its ability to adapt to a wider range of conditions in part helps to explain its overall wide distribution.

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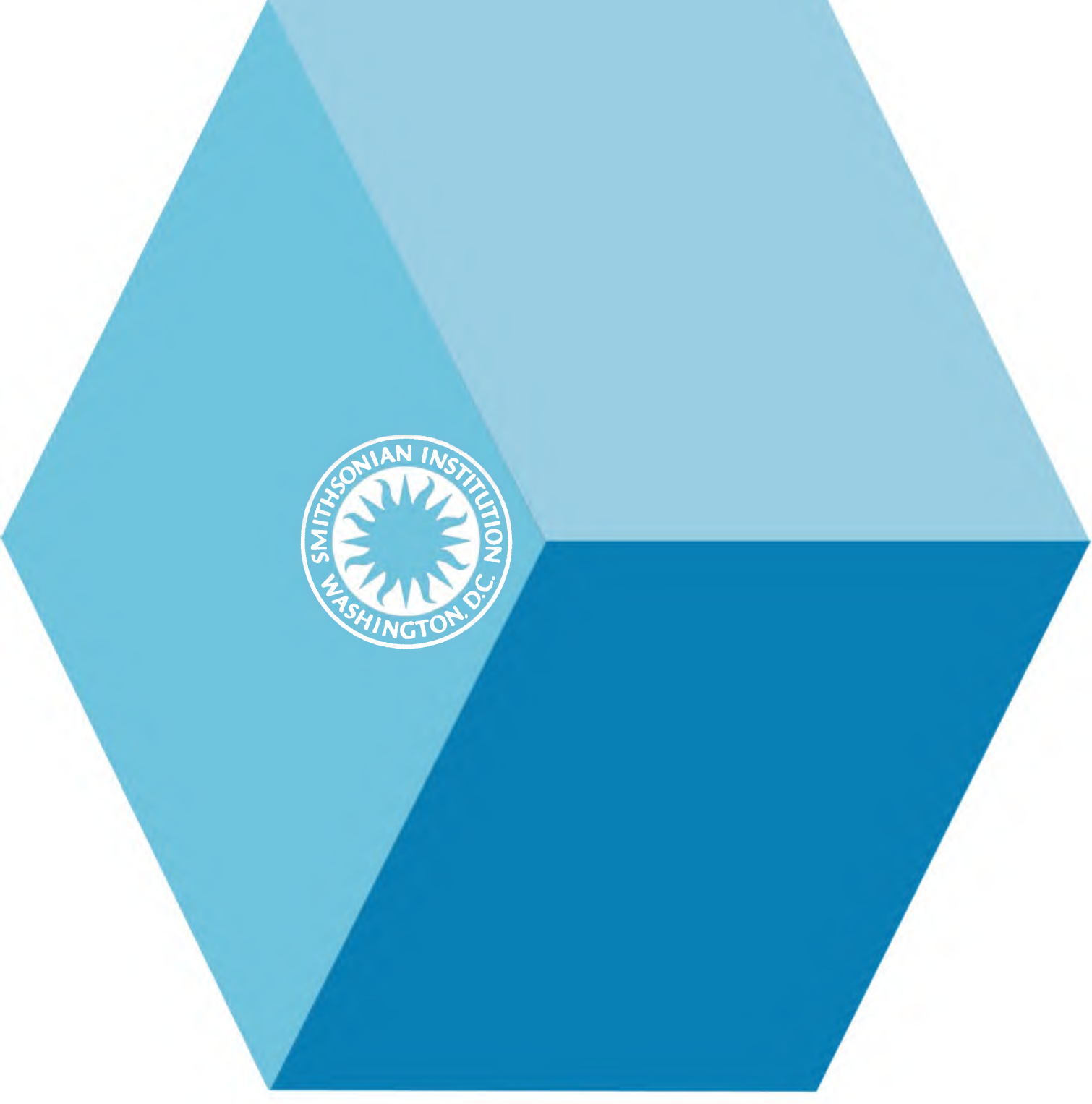
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