4.3. Insects of Papua

SCOTT E. MILLER

INSECTS AND OTHER terrestrial invertebrates are tremendously diverse in Papua, and play vital roles in providing ecosystem services, but are poorly known. Insects are interesting for conservation studies for the following reasons: (1) generality of distribution: insects are found in almost every conceivable habitat and niche; (2) within this overall versatility, there is much specialization; (3) many taxa show rapid responses to environmental perturbation; (4) some taxa are readily identifiable without specialized training; (5) many taxa are good indicators of areas of endemism; and (6) many taxa are readily sampled with quantitative methods, providing high quality data for statistical analyses (see Brown 1991; Holloway and Stork 1991; Kremen et al. 1993; Miller and Rogo 2002; Sutton and Collins 1991).

History

Frodin and Gressitt (1982; Chapter 2.1) have presented excellent descriptions of the history of biological exploration in New Guinea and only the major elements are repeated here (see also van Steenis-Kruseman 1950). The Papuan fauna cannot be understood in isolation because much of the fauna is shared with Papua New Guinea, the Solomon Islands, and Australia. Most groups of insects have been more extensively sampled in Papua New Guinea than Papua, so it is often necessary to extrapolate from knowledge of Papua New Guinea to understand the Papuan fauna. The entomological literature for the New Guinea region was compiled by Gressitt and Szent-Ivany (1968), and is available online in an updated version at http://entomology.si.edu.

The first comprehensive insect collecting in Papua was undertaken by European collectors starting in the 1870s and continuing into the 1930s. These collectors included E. Cheesman, W. Doherty, H. A. Lorentz, E. Mayr, A. S. Meek, W. G. Meek, A. E. Pratt, H. Pratt, and A. F. R. Wollaston. The Third Archbold Expedition (1938–1939) was the only one of the Archbold Expedition series that visited Papua and it provided an unsurpassed sample of the fauna of the Mamberamo Basin and headwaters (Archbold et al. 1942). During World War II, many United States and Australian entomologists collected in coastal Papua. In the 1950s, J. L. Gressitt of the Bishop Museum organized surveys of Papuan insects. Little research was done on insects in Papua from the 1960s through the 1980s. Terrestrial insects have been included in conservation surveys starting in the 1990s, but only in a small way (e.g., Polhemus and Polhemus 2000; Rosariyanto et al. 2002; van Mastright and Rosariyanto 2002; Oppel 2006).

Major collections of Papua's terrestrial invertebrates are housed at Bishop Mu-

Marshall, A. J., and Beehler, B. M. (eds.). 2006. *The Ecology of Papua.* Singapore: Periplus Editions.

................16157$ CH36 02-08-07 10:39:31 PS PAGE 515

seum, Honolulu (BPBM); Museum Zoologense Bogeriense, Bogor (MZB); Natural History Museum (formerly British Museum of Natural History), London (NHM); National Museum of Natural History (formerly Rijksmuseum van Natuurlijke Historie), Leiden (RNH); American Museum of Natural History, New York (AMNH); Smithsonian Institution, Washington DC (USNM); and the University of Amsterdam. A small collection, which should be upgraded, exists at Cenderawasih University, Manokwari campus, Papua.

Status of General Knowledge

Knowledge of insects and other invertebrates of New Guinea varies tremendously among taxonomic groups and localities, according to the history of sampling and study, and the biological complexity of the group. For example, butterflies are well known in some areas (e.g., Gotts and Pangemanan 2001; van Mastrigt and Rosariyanto 2005), but little is known about soil arthropods at most sites in New Guinea (Hammen 1983). The components involved in understanding insects include the following:

1. Sampling of basic diversity: collecting and preservation for study. Basic sampling has taken place for many groups, although the smaller and more difficult to study taxa are almost always undersampled. Geographic coverage of sampling is poor in Papua, even for butterflies.
2. Systematic study of these samples: diagnosis of species and other taxonomic units. The quality and quantity of systematic study varies with historical interest from group to group. Some taxa are relatively well known, but information transfer is a problem for all groups. The recent text on Australian insects (CSIRO 1991) is very helpful for understanding the New Guinea fauna.
3. Field studies on the biology, ecology, and geographic distribution of species. Except for species of economic interest to agriculture (e.g., Simon Thomas 1962; Ubaidillah 1991), forestry (Nair 2000), or medicine (Bangs and Subianto 1999; Owen 2005), little is known about the ecology of Papua's insects. In addition, little is known about the distribution of insects in ecological space, including issues such as host specificity, and the distribution of individuals and biomass per species within ecosystems (Novotny et al. 2002a, 2006).

However, as noted above, the great diversity of insects is a positive feature, allowing researchers to choose specific groups that can answer specific questions in a statistically meaningful manner. Modern information management techniques provide at least a partial solution to the information transfer problem.

Status of Taxonomic Knowledge

As noted above, taxonomic knowledge of New Guinea insects varies greatly from group to group. There is no comprehensive review for any major group except the flies, and the bibliography by Gressitt and Szent-Ivany (1968) is the only broad attempt to synthesize knowledge of New Guinea insects. The following is a brief overview of the state of taxonomic knowledge of New Guinea insects, including major references. Major taxonomic units follow the recent text on Australian insects (CSIRO 1991) which is an important general review. Simon Thomas (1962) reviewed agricultural entomology in Papua, and Hammen (1983) includes a review of the meager knowledge of soil arthropods. "Very poorly known" in the list below indicates that only very basic surveys have been done, little is known about biogeography and distribution, and no ecological studies have been done (except sometimes for selected pest organisms).

There is no comprehensive list of insects recorded from Papua (or New Guinea), and any estimate must be based on assumptions and extrapolation (e.g., Novotny et al. 2002c). Miller (1996) estimated the total insect fauna of New Guinea might be 300,000 species (Table 4.3.1). The diversity of insects in Australia has recently been reviewed by Austin et al. (2004) and Yeates et al. (2003), who reached the conclusion that the insect fauna of Australia is something over 200,000 species. In light of the new Australian estimates, and the lower host specificity estimates in Novotny et al. (2002c), the insect fauna of New Guinea is likely less than 300,000 species, of which many remain to be described.

Larger insects in the lowland areas are relatively well known, at least in the sense of having species names (Novotny et al. 2005; S. Miller, unpublished data). However, it is often impossible to associate the species name with a specimen without reference to historic collections in Europe because the species have never been adequately characterized in the literature. But the fauna of larger insects at higher elevations (above about 1,000 m) is poorly known (Novotny et al. 2005; Riedel 2001; S. Miller, unpublished data), and the fauna of small insects (as well as mites and other tiny arthropods) is poorly known throughout Papua. There is very little overlap in species between the lowlands and higher elevations, although the nature of the transition in faunas with elevation is not yet adequately explored (Allison et al. 1993; Novotny et al. 2005).

Table 4.3.1. Numbers of invertebrate species known from New Guinea

Taxon	Number of species	Source
Terrestrial flatworms	4	de Beauchamp 1972
Freshwater rotifers	135	Segers and de Meester 1994
Nematodes of plants	63	Bridge and Page 1984
Terrestrial mollusks	1,000	Cowie 1993
Leeches (part)	5	van der Lande 1993
Earthworms	42	Nakamura 1992
Onychophora	7	van der Lande 1993
Insects	300,000	Miller 1996

Order Collembola (Springtails): Very poorly known in Papua (Yoshii and Suhardjno 1992).

Order Protura: Very poorly known for Papua (Tuxen 1964).

Order Diplura: Very poorly known for Papua (Paclt 1985).

Order Archaeognatha (= Microcoryphia) (Bristletails): Very poorly known for Papua (Strum 1999, Strum and Machida 2001).

Order Thysanura (Silverfish): Very poorly known for Papua (Paclt 1982).

Order Ephemeroptera (Mayflies): Very poorly known for New Guinea (Edmunds and Polhemus 1990).

Order Odonata (Dragonflies and damselflies): Relatively well known from extensive work of Lieftinck (1949).

Order Plecoptera (Stoneflies): The only record in Papua is an unidentified species recently collected by D. A. Polhemus (pers. comm.).

Order Blattodea (= Blattaria) (Cockroaches): Relatively poorly known. There is only a scattered literature for Papua, partially reviewed by Roth (2003).

Order Isoptera (Termites): Relatively poorly known for Papua. Cataloged by Snyder (1949). Nasute termites of Papua New Guinea revised by Roisin and Pasteels (1996).

Order Mantodea (Praying mantids): Relatively well known for New Guinea (Beier 1965; Rentz 1996).

Order Dermaptera (Earwigs): Relatively poorly known for Papua; see world checklist by Steinmann (1989).

Order Orthoptera (Grasshoppers, locusts, katydids, crickets): Larger taxa relatively well known in Papua, but the literature for New Guinea is scattered. See Rentz (1996) and Willemse (2001).

Order Phasmatodea (Stick insects): Relatively well known in New Guinea (van Herwaarden 1998; Nakata 1961; Rentz 1996).

Order Embioptera (= Embiidina) (Web-spinners): Relatively poorly known in Papua (Ross 1948).

Order Zoraptera: Not yet known to occur in New Guinea (Smithers, in CSIRO 1991).

Order Psocoptera (Psocids, booklice): Generally poorly known in New Guinea, although some groups recently revised (Lienhard and Smithers 2002; Smithers and Thornton 1981).

Order Phthiraptera (including Mallophaga and Anoplura) (Lice): Generally poorly known in New Guinea (Durden and Musser 1994; Ferris 1951; Price 2003).

Order Hemiptera (including Heteroptera and Homoptera) (Bugs, leafhoppers, cicadas, aphids, scale insects, etc.): Knowledge very uneven for New Guinea. Some groups have modern revisions (especially some Cicadidae, Coccoidea, Miridae, Flatidae, Cicadellidae, aquatic Heteroptera, etc.), but others do not. See Stonedahl and Dolling (1991) for literature on Heteroptera.

Order Thysanoptera (Thrips): Generally poorly known for New Guinea but partially treated in recent revisions by L. A. Mound and others.

Order Megaloptera (Alderflies, dobsonflies): Not yet known from New Guinea.

Order Raphidioptera (Snakeflies): Not yet known from New Guinea.

Order Neuroptera (Lacewings, etc.): Relatively well known in New Guinea because of publications by T. R. New and colleagues, reviewed by New (2003).

Order Coleoptera (Beetles): A very diverse group in New Guinea, ranging from relatively well known (e.g., Carabidae, Chyrsomelidae) to very poorly known (e.g., Scarabaeidae, Curculionidae). General review by Gressitt and Hornabrook (1977). Several large families reviewed by Bigger and Schofield (1983).

Order Strepsiptera: A small parasitic group reviewed by Kifune and Hirashima (1989) and Kathirithamby (1989).

Order Mecoptera (Scorpionflies): Not known from New Guinea (Penny and Byers 1979).

Order Siphonaptera (Fleas): Relatively well known in New Guinea; monographed by Holland (1969).

Order Diptera (Flies): A very diverse group in New Guinea, ranging from relatively well known (e.g., Culicidae, Simuliidae; e.g., Takaoka 2003) to very poorly known (e.g., Chironomidae). Reviewed by Evenhuis (1989) and Oosterbroek (1998).

Order Trichoptera (Caddisflies): Reviewed by Neboiss (1986, 1989), but many taxa remain to be sampled and described.

Order Lepidoptera (Moths and butterflies): A very diverse group in New Guinea, ranging from relatively well known (e.g., butterflies) to very poorly known (e.g., Microlepidoptera). General review and identification guide by Holloway et al. (2001). Butterflies partially reviewed by Parsons (1998) and van Mastrigt and Rosariyanto (2005); Papilionidae are reviewed by Ubaidillah et al. (1994). Microlepidoptera reviewed by Diakonoff (1952–1955), but many taxa remain to be described.

Order Hymenoptera (Wasps, bees, ants, sawflies): A very diverse group in New Guinea, ranging from relatively well known (e.g., ants) to very poorly known (e.g., many parasitic wasps).

Terrestrial invertebrates other than insects have generally been very poorly sampled and studied in New Guinea. It is worth noting that terrestrial and freshwater mollusks are better known in Papua than in Papua New Guinea, although they remain poorly understood (Cowie 1993). For further discussion of invertebrate diversity see Ewers (1973), Miller (1996), and Sekhran and Miller (1996).

Biogeography

New Guinea and surrounding islands provide major challenges for understanding the complex interrelationships of "mobile organisms in a geologically complex area" (Holloway 1982). The island of New Guinea has evolved as a major land area only over the past ten or so million years, through fusion and compression of inner and outer Melanesian island arcs between the northward moving Australian continent on the Indian Ocean tectonic plate and the westward moving margin of the Pacific tectonic plate. Only in the Pliocene and Pleistocene were its mountain ranges uplifted to the snow line, to be glaciated extensively during the latter period. Despite this geological youth, the insect fauna has attained a diversity that appears to be equivalent to that of the much older tropical lands of Southeast Asia (Gressitt 1982b). The majority of this fauna has its closest relationships with that of Asia, with the genera tending to be fewer in number but more species-rich. For instance, the majority of moth genera endemic to Melanesia are restricted to, or have their species richness strongly centered in, New Guinea (Holloway 1984b). Rapid development of high diversity in a geologically unstable environment with high relief is counter to some hypotheses of tropical diversity, particularly those based on environmental stability over long periods of geological time. Therefore studies of the biogeographic origins of the New Guinea fauna and speciation patterns within it are likely to throw considerable light on the processes leading to increases in species richness (Holloway 1991).

Although many authors have addressed the biogeographic relationships of the New Guinea fauna to those of adjacent regions, particularly in regard to the importance of Australian versus Asian elements, few authors have attempted analyses of biogeography within New Guinea (especially patterns of regional endemism). The paucity of data for regionalization of New Guinea became very clear in an extensive literature survey for the Papua New Guinea Conservation Needs Assessment, an attempt to identify the areas within the country of greatest importance to biodiversity conservation. Even among the relatively well known ground beetles (Coleoptera: Carabidae), patterns based only on literature records proved misleading. For example, of 11 carabids that were known only from the Northern Province lowlands (putative regional endemics), four were represented in the Bishop Museum by specimens from outside of the Northern Province lowlands (Miller 1993). Thus, previously unpublished data from museum collections will be important to a comprehensive view of invertebrate biogeography in New Guinea. The best analyses of regional patterns are those for cicadas (de Boer 1995; de Boer and Duffels 1996a,b; Duffels and de Boer 1990; and Chapter 4.4) and aquatic insects (Chapter 2.5; Polhemus 1996, 1998). There are relatively few modern revisions (i.e., those applying modern species concepts to adequate samples) of speciose groups in New Guinea. Among the taxa for which such data exist are some groups of mosquitoes, black flies, sarcophagid flies, aquatic bugs, ground beetles, chrysomelid beetles, pyraloid moths, butterflies, and cicadas.

Based on intensive studies of cicada distributions, Papua can be subdivided into four main areas of endemism, each with its own distinct biota (see Chapter 4.4): the Vogelkop peninsula, the northern mountain ranges, the central mountain ranges, and south New Guinea. The latter three continue into Papua New Guinea.

For most groups of invertebrates, all of Papua needs intensive collecting using modern sampling techniques. Even where samples do exist, they are often limited to material from early expeditions and usually to larger species (e.g., butterflies, cicadas). But a huge area of Papua has received no serious sampling for insects. Some of the areas that are especially poorly known are: (1) The Vogelkop area, other than the Arfak Mountains; areas around Sorong, Fakfak, and Manokwari, and the Wasior Peninsula, are almost unknown; (2) Papua north of the Central

Range is largely unknown except for the coastal areas (especially around Nabire and Jayapura) and the Cyclops Mts; (3) The Central Range from the Weyland Mts to the Baliem Valley, and the Star Mts; and (4) the southeastern lowlands from the Lorentz National Park to the Wasur area (including Yos Sudarso (Kimaam) Island) remain unknown (Miller 1998).

Ecology and Conservation

So little is known about the ecology of most New Guinea insects that it is difficult to identify ecologically critical areas. In general, the highest diversity is found in primary forest, but little study has been devoted to the ecology of savanna and wetlands insects in New Guinea and it is possible that important patterns of diversity are being overlooked (e.g., Pimm and Gittleman 1992). Because of the need for calcium for shell formation, the highest diversity of land snails is expected in limestone areas with high soil pH (Andrews and Little 1982; Cowie 1993). Preservation of isolated limestone outcrops will be especially important in the conservation of maximum diversity of land snails.

The impact of habitat disturbance on insects depends upon, among other things, the life history strategies of the insect species involved. Although this has received little study in New Guinea (Bowman et al. 1990; Novotny et al. 2004), most native insects respond poorly to severe habitat degradation. Loss of diversity from disturbance of forests affects some taxonomic groups more seriously than others (see Miller and Holloway 1992 and Hill et al. 1995 for examples from other Indonesian islands). Insects with narrow dietary requirements or other habitat specialization tend to be most readily affected by habitat degradation. However, some insect populations recover relatively well after disturbance. For example, in Seram, moth diversity in shifting cultivation areas that were abandoned several decades ago, which are now well forested, is comparable with that of undisturbed forest at similar altitudes (Miller and Holloway 1992). It is therefore possible that a sustainable cycle of forest exploitation or farming that permits a full regeneration cycle will only temporarily depress biodiversity, although this may be dependent on the proportion of climax forest present throughout the progression of such cycles. However, conversion of lowland forest to field or cash crop plantations will depress moth diversity to a much lower level, as seen in Sulawesi (Miller and Holloway 1992).

Economically Important Species

The most widely recognized economically important species of insects are pests of agriculture and forestry, and vectors of diseases. Although a great many species have some negative economic importance in Papua (Simon Thomas 1962), they constitute only a very minor fraction of the total fauna. However, as primary forest resources are depleted in the future, and more plantations (particularly of leguminous trees) are established, these economic activities and developments will be affected by insect attack, particularly from defoliating insects.

In Papua, most of the agricultural pest insects are native, and new "pests" frequently emerge from the indigenous fauna in response to natural or human-induced changes (Simon Thomas 1962, Kumar 2001). Szent-Ivany (1961) showed that while 98% of the then insect pests of Hawai'i were introduced by humans, less than 3% (1 of 34) of the then major agricultural insect pests in New Guinea were introduced. Furthermore, many of the economic crops (e.g., sugar) are native to the region. Thus a high "pest" potential, especially in crop monocultures, exists in this region. The current emphasis in forestry to plant legumes and *Eucalyptus* in monoculture after natural forest is cleared, will almost inevitably lead to major pest problems because these crops are in the preferred host families for many moths. Thus, for natural resource management, it will be important to have basic data on the insect fauna of Papua. Pest exclusion and detection programs, such as inspections and quarantines of incoming commodities, regular surveys for target pests, and local diagnostic services supported by international laboratories are important to prevent future problems.

Large-scale conversion of primary forest to other uses can result in outbreaks of a variety of pests, especially disease vectors. This should be factored into cost-benefit analyses of programs. Ross River alphavirus and Murray River encephalitis present likely prospects for intensified disease prevalence wherever lowland forests are disturbed and people aggregated (Jenkins 1992). Clearing of native forest barriers has allowed pest locusts to move into new areas in Africa and could happen in New Guinea (Miller 1993).

Many of the large, colorful insects of Papua, especially butterflies, have a commercial market value. Butterfly farming activities in New Guinea are generally considered successful (e.g., studies in Papua New Guinea by Clark and Landford 1991; Collins and Morris 1985:29; Orsak 1993; Parsons 1998; Sekhran and Miller 1996; and in Papua by Mercer 1997; Morris 1986; and Parsons 1982). Nevertheless, a detailed analysis of the economic and conservation impact of butterfly farming would be useful in planning future expansion of the program (e.g., Goldstein 1991). It is clear that butterfly farming has raised the awareness, both locally and internationally, of conservation issues and of the potential value of New Guinean native fauna. Butterfly farming could clearly benefit from more research on effective methods of rearing rare species in captivity. Insects are also important food resources for many local people (Mercer 1997; Ponzetta and Paoletti 1997).

Perennial malaria, vectored by mosquitoes in the *Anopheles punctulatus* complex, is a major public health problem for most coastal, lowland, and foothill populations in Papua. Malaria at higher elevations (above 1,500 m) is considered intermittent and highly unstable, providing a constant threat of epidemics (Bangs and Subianto 1999). Relatively few species of zoonotic parasites have been recorded in humans in Papua New Guinea (Owen 2005). Among them are flies (*Chrysomya bezziana*), bed bugs (*Cimex* sp.), fleas (*Ctenocephalides* spp.), and mites (*Leptotrombidium* spp., *Sarcoptes scabiei*, and *Demodex* sp.). The paucity of zoonotic parasite species can be attributed to long historical isolation of the island of New Guinea and its people, and the absence until recent times of large placental mammals other than pigs and dogs (Owen 2005).

Threats

The largest important threat to most insects is habitat disturbance. In most cases, this means destruction of the integrity of primary forests and other natural habitats. Some species might be threatened by alien species (e.g., by predation, parasitism, or competition). Alien species are probably a minor threat to native insects in most of mainland Papua, but can be significant in areas of heavy human disturbance (e.g., Snelling 1998) and islands that host many endemic species (e.g., Howarth and Ramsay 1991; Nishida and Evenhuis 2000; Williams 1994). However, alien species can be difficult to detect before they become widespread. The arboreal termite originally known as the New Guinea endemic *Nasutitermes polygynus* Roisin and Pasteels was recently found to be an accidental introduction of *Nasutitermes corniger* (Motschulsky) from the New World tropics (Scheffrahn et al. 2005). Biological control introductions should be carefully screened to prevent excessive impact on nontarget organisms (Howarth 1991).

Overcollecting is a threat only to large species with very restricted populations, such as birdwing and *Delias* butterflies. Many butterflies are already protected by Indonesian law (Simbolon and Iswari 1990), although it is not clear how effective this protection has been.

The effects of pollution on invertebrates in Papua have received almost no study, but may prove to be important. Chemical pollutants from mining and increased sedimentation from deforestation are likely to heavily impact aquatic insects, crustacea, and mollusks. Chemical pesticides used for agriculture, forestry, and vector control can impact both terrestrial and aquatic invertebrates.

Note: Since this chapter was written, the Papua Insects Foundation has started a web site at www.papua-insects.nl that includes diverse information on Papua insects.

Acknowledgments

A. Allison, M. Amir, Y. Basset, R. Cowie, A. de Boer, K. Darrow, H. Duffels, N. L. Evenhuis, J. D. Holloway, K. Kami, H. van Mastrigt, E. G. Munroe, T. R. New, Y. Novotny, L. J. Orsak, M. Parsons, D. A. Polhemus, F. C. Thompson, G. Weiblen, A. Yaku, and R. I. Vane-Wright contributed information or ideas for this paper over many years of study, which have been supported by the Bishop Museum, National Science Foundation, and Smithsonian Institution.

Literature Cited

Allison, A. 1992. The role of museums and zoos in conserving biological diversity in Papua New Guinea. Pp. 59–63, 74 in Pearl, M., et al. (eds.) *Conservation and*

Environment in Papua New Guinea: Establishing Research Priorities. Embassy of Papua New Guinea, Washington, D.C., and Wildlife Conservation International, Bronx, New York.

Allison, A., G.A. Samuelson, and S.E. Miller. 1993. Patterns of beetle species diversity in New Guinea rain forest as revealed by canopy fogging: preliminary findings. *Selbyana* 14: 16–20.

Andrews, E.B., and C. Little. 1982. Renal structure and function in relation to habitat in some cyclophorid land snails from Papua New Guinea. *Journal of Molluscan Studies* 48: 124–143.

Archbold, R., A.L. Rand, and L.J. Brass. 1942. Results of the Archbold Expeditions, no. 41. summary of 1938–39 New Guinea expedition. *Bulletin of the American Museum of Natural History* 79: 197–288.

Ashe, P. 1990. Ecology, zoogeography and diversity of Chironomidae (Diptera) in Sulawesi with some observations relevant to other aquatic insects. Pp. 261–268 in Knight, W.J., and J.D. Holloway (eds.) *Insects and the Rain Forests of South East Asia (Wallacea).* Royal Entomological Society, London.

Austin, A.D., D.K. Yeates, G. Cassis, M.J. Fletcher, J. LaSalle, J.F. Lawrence, P.B. McQuillan, L.A. Mound, D.J. Bickel, P.J. Gullan, D.F. Hales, and G.S. Taylor. 2004. Insects "Down Under"—diversity, endemism and evolution of the Australian insect fauna: examples from select orders. *Australian Journal of Entomology* 43: 216–234.

Bangs, M.J., and D.B. Subianto. 1999. El Niño and associated outbreaks of severe malaria in highland populations in Irian Jaya, Indonesia: a review and epidemiological perspective. *Southeast Asian Journal of Tropical Medicine and Public Health* 30: 608–619.

Beier, M. 1965. Die Mantodeen Neu-Guineas. *Pacific Insects* 7: 473–502.

Bigger, M., and P. Schofield. 1983. Checklist of Cerambycidae, Curculionidae, Attelabidae, Scolytidae and Platypodidae of Melanesia. *Overseas Development Administration* (London) *Miscellanous Report* 60: 1–62.

Bowman, D.M.J.S., J.C.Z. Woinarski, D.P.A. Sands, A. Wells, and V.J. McShane. 1990. Slash-and-burn agriculture in the wet coastal lowlands of Papua New Guinea: response of birds, butterflies and reptiles. *Journal of Biogeography* 17: 227–239.

Bridge, J., and S.L.J. Page. 1984. Plant nematode pests of crops in Papua New Guinea. *Journal of Plant Protection in the Tropics* 1: 99–109.

Brown, K.S., Jr. 1991. Conservation of neotropical environments: Insects as indicators. Pp. 349–404 in Collins, N.M., and J.A. Thomas (eds.) *The Conservation of Insects and Their Habitats.* Academic Press, London.

Clark, P.B., and A.D. Landford. 1991. Farming insects in Papua New Guinea. *International Zoo Yearbook* 30: 127–131.

Collins, N.M., and M.G. Morris. 1985. *Threatened Swallowtail Butterflies of the World: The IUCN Red Data Book.* IUCN, Cambridge.

Cowie, R.H. 1993. Non-Marine Mollusca of Papua New Guinea. Pp. 311–320 in Beehler, B.M. (ed.) *Papua New Guinea Conservation Needs Assessment,* vol. 2. Papua New Guinea Department of Environment and Conservation, Boroko.

Cranston, P.S. 1990. Biomonitoring and invertebrate taxonomy. *Environmental Monitoring and Assessment* 14: 265–273.

CSIRO. 1991. *The Insects of Australia: A Textbook for Students and Research Workers.* 2nd ed. 2 vols. Melbourne University Press, Melbourne.

de Beauchamp, P. 1972. Planaires terrestres de Nouvelle-Guinée. *Cahiers du Pacifique* 16: 181–192.

de Boer, A.J. 1989. The taxonomy and biogeography of the *bloetei* group of the genus *Baeturia* Stål, 1866 (Homoptera, Tibicinidae). *Beaufortia* 39: 1–43.

de Boer, A.J. 1995. Islands and cicadas adrift in the west-Pacific. Biogeographic patterns related to plate tectonics. *Tijdschrift voor Entomologie* 138: 169–244.

de Boer, A.J., and J.P. Duffels. 1996a. Biogeography of Indo-Pacific cicadas east of Wallace's Line. Pp. 297–330 in Keast, A., and S.E. Miller (eds.) *The Origin and Evolution of Pacific Island Biotas, New Guinea to Eastern Polynesia: Patterns and Processes.* SPB Academic Publishing, Amsterdam.

de Boer, A.J., and J.P. Duffels. 1996b. Historical biogeography of the cicadas of Wallacea, New Guinea and the West Pacific: a geotectonic explanation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 124: 153–177.

Diakonoff, A. 1952–1955. Microlepidoptera of New Guinea. Results of the Third Archbold Expedition (1938–39). Parts I–V. *Verh. Akad. Wet Amst. (Natuurk.)*, ser. 2, 49 (2): 1–167; 49 (3): 1–166; 49 (4): 1–164; 50 (1): 1–191; 50 (3): 1–210.

Duffels, J.P. 1977. A revision of the genus *Diceropyga* Stål, 1870 (Homoptera, Cicadidae). *Mono. Ned. Ent. Vereen.* 8: 1–227.

Duffels, J.P. 1983a. Distribution patterns of Oriental Cicadoidea (Homoptera) east of Wallace's Line and plate tectonics. *GeoJournal* 7: 491–498.

Duffels, J.P. 1983b. Taxonomy, phylogeny and biogeography of the genus *Cosmopsaltria*, with remarks on the historic biogeography of the subtribe Cosmopsaltriaria (Homoptera: Cicadidae). *Pacific Insects Monograph* 39: 1–127.

Duffels, J.P. 1986. Biogeography of Indo-Pacific Cicadoidea: a tentative recognition of areas of endemism. *Cladistics* 2: 318–336.

Duffels, J.P., and A.J. de Boer. 1990. Areas of endemism and composite areas in East Malesia. Pp. 249–272 in Baas, P., K. Kalkman, and R. Geesink (eds.) *The Plant Diversity of Malesia.* Kluwer Academic Publishers, Dordrecht.

Durden, L.A., and G.G. Musser. 1994. The sucking lice (Insecta, Anoplura) of the world: a taxonomic checklist with records of mammalian hosts and geographical distributions. *Bulletin of the American Museum of Natural History* 218: 1–90.

Edmunds, G.F., Jr., and D.A. Polhemus. 1990. Zoogeographical patterns among mayflies (Ephemeroptera) in the Malay Archipelago, with special reference to Celebes. Pp. 49–56 in Knight, W.J., and J.D. Holloway (eds.) *Insects and the Rain Forests of South East Asia (Wallacea).* Royal Ent. Soc., London.

Erwin, T.L. 1975. Studies of the subtribe Tachyina (Coleoptera: Carabidae: Bembidiini), Part III: systematics, phylogeny, and zoogeography of the genus *Tachyta* Kirby. *Smithsonian Contributions to Zoology* 208: 1–68.

Evenhuis, N.L. (ed.). 1989. *Catalog of the Diptera of the Australasian and Oceanian Regions.* Bishop Museum Press and E.J. Brill, Honolulu and Leiden.

Ewers, W.H. 1973. Bibliography of invertebrate animals from New Guinea. *Science in New Guinea* 1: 41–46.

Ferris, G.F. 1951. The sucking lice. *Memoirs of the Pacific Coast Entomological Society* 1: 1–321.

Frodin, D.G., and J.L. Gressitt. 1982. Biological exploration of New Guinea. Pp. 87–130 in Gressitt, J.L. (ed.) *Biogeography and Ecology of New Guinea.* W. Junk, The Hague.

Goldstein, J.H. 1991. The prospects for using market incentives to conserve biological diversity. *Environmental Law* 21: 985–1014.

Gotts, R.I.C., and N. Pangemanan. 2001. *Mimika butterflies: a guide to the butterflies of the Mimika subdistrict of Papua.* PT Freeport Indonesia Biodiversity Centre, Timika, Indonesia.

Gressitt, J.L. 1982a. Pacific-Asian biogeography with examples from the Coleoptera. *Entomologica Generalis* 8: 1–11.

Gressitt, J.L. 1982b. Zoogeographical summary. Pp. 897–918 in Gressitt, J.L. (ed.) *Biogeography and Ecology of New Guinea.* W. Junk, The Hague.
Gressitt, J.L., and R.W. Hornabrook. 1977. *Handbook of Common New Guinea Beetles.* Handbook 2. Wau Ecology Institute, Wau.
Gressitt, J.L., and J.J.H. Szent-Ivany. 1968. Bibliography of New Guinea entomology. *Pacific Insects Monograph* 18: 1–674.
Hammen, L. van der. 1983. Contribution to the knowledge of the soil-fauna of New Guinea. *Zoologische Verhandelingen* 206:1–36, pl. 1–19.
Haugum, J., and A.M. Low. 1978–1985. *A Monograph of the Birdwing Butterflies.* 2 vols. Scandinavian Science Press, Klampenborg, Denmark.
Hebert, P.D.N. 1980. Moth communities in montane Papua New Guinea. *Journal of Animal Ecology* 49: 593–602.
Hill, J.K., K.C. Hamer, L.A. Lace, and W.M.T. Banham. 1995. Effects of selective logging on tropical forest butterflies on Buru, Indonesia. *Journal of Applied Ecology* 32: 752–760.
Holland, G.P. 1969. Contribution towards a monograph of the fleas of New Guinea. *Memoirs of the Entomological Society of Canada* 61: 1–77.
Holloway, J.D. 1977. *The Lepidoptera of Norfolk Island: Their Biogeography and Ecology.* W. Junk, The Hague.
Holloway, J.D. 1979. *A Survey of the Lepidoptera, Biogeography and Ecology of New Caledonia.* W. Junk, The Hague.
Holloway, J.D. 1983. Insect surveys—an approach to environmental monitoring. Pp. 239–261 in Atti XII Cong. Naz. Ital. Ent. (Rome, 1980).
Holloway, J.D. 1984a. Moths as indicator organisms for categorizing rain-forest and monitoring changes and regeneration processes. Pp. 235–242 in Chadwick, A.C., and S.L. Sutton (eds.) *Tropical Rain-Forest: The Leeds Symposium.* Leeds Philosophical and Literary Society, Leeds.
Holloway, J.D. 1984b. The larger moths of the Gunung Mulu National Park: a preliminary assessment of their distribution, ecology, and potential as environmental indicators. *Sarawak Museum Journal* 30: 149–190.
Holloway, J.D. 1984c. Lepidoptera and the Melanesian Arcs. Pp. 129–169 in Radovsky, F.J., et al. (eds.) *Biogeography of the Tropical Pacific.* Bishop Museum Special Publication 72. Bishop Museum, Honolulu.
Holloway, J.D. 1987. Bracken-feeding Geometridae in the genus *Idiodes* Guenee, 1857, and allied taxa in the tribe Lithinini (Lepidoptera). *Tinea* 12 (supplement): 242–248.
Holloway, J.D. 1989. Moths. Pp. 437–453 in Lieth, H. (ed.) *Tropical Rain Forest Ecosystems. Ecosystems of the World,* vol. 14B. Elsevier, Amsterdam.
Holloway, J.D. 1991. Patterns of moth speciation in the IndoAustralian archipelago. Pp. 340–372 in Dudley, E.C. (ed.) *The Unity of Evolutionary Biology: Proceedings of the Fourth International Congress of Systematic and Evolutionary Biology.* Dioscorides Press, Portland, Oregon.
Holloway, J.D. 1993. Aspects of the biogeography and ecology of the Seram moth fauna. Pp. 91–114 in Edwards, I.D., A.A. Macdonald, and J. Proctor (eds.) *The Natural History of Seram, Maluku, Indonesia.* Intercept, Andover.
Holloway, J.D., and H.S. Barlow. 1992. Potential for loss of biodiversity in Malaysia, illustrated by the moth fauna. Pp. 293–311 in Kadir, A.A.S.A., and H.S. Barlow (eds.) *Pest Management and the Environment in 2000.* CAB International, Wallingford, U.K.
Holloway, J.D., G.S. Robinson, and K.R. Tuck. 1990. Zonation in the Lepidoptera of northern Sulawesi. Pp. 153–166 in Knight, W.J., and J.D. Holloway (eds.) *Insects and the Rain Forests of South East Asia (Wallacea).* Royal Entomological Society, London.

Holloway, J.D., and N.E. Stork. 1991. The dimensions of biodiversity: the use of invertebrates as indicators of man's impact. In Hawksworth, D.L. (ed.) *The Ecological Foundations of Sustainable Agriculture.* CAB International, Wallingford, U.K.

Howarth, F.G. 1991. Environmental impacts of classical biological control. *Ann. Rev. Ent.* 36: 485–509.

Howarth, F.G., and G.W. Ramsay. 1991. The conservation of island insects and their habitats. Pp. 71–107 in Collins, N.M., and J.A. Thomas (eds.) *The Conservation of Insects and Their Habitats.* Academic Press, London.

Hurlbert, S.H., and A. Villalobos-Figueroa (eds.). 1982. *Aquatic Biota of Mexico, Central America and the West Indies.* San Diego State University, San Diego, California.

Janzen, D.H. 1984. Two ways to be a tropical big moth: Santa Rosa saturniids and sphingids. *Oxford Surveys in Evolutionary Biology* 1: 85–140.

Jenkins, C. 1992. Environmental change and human health in Papua New Guinea. Pp. 75–82 in Pearl, M., et al. (eds.) *Conservation and Environment in Papua New Guinea: Establishing Research Priorities.* Embassy of Papua New Guinea, Washington, D.C., and Wildlife Conservation International, Bronx, New York.

Kathirithamby, J. 1989. Review of the order Strepsiptera. *Systematic Entomology* 14: 41–92.

Kifune, T., and Y. Hirashima. 1989. Taxonomic studies on the Strepsiptera in the collection of Bishop Museum (Notulae Strepsipterologicae–XX). *Esakia* 28: 11–48.

Kremen, C., R.K. Colwell, T.L. Erwin, D.D. Murphy, R.F. Noss, and M.A. Sanjayan. 1993. Terrestrial arthropod assemblages: their use in conservation planning. *Conservation Biology* 7: 796–808.

Kumar, R. 2001. Insect Pests of Agriculture in Papua New Guinea. Part 1. Principles and Practice, Pests of Tree Crops and Stored Products. *Science in New Guinea,* Port Moresby, Papua New Guinea.

Lieftinck, M.A. 1949. The dragonflies (Odonata) of New Guinea and neighbouring islands. Part VII. *Nova Guinea,* n.s. 5: 1–271.

Lienhard, C., and C. N. Smithers. 2002. *Pscoptera (Insecta): World Catalogue and Bibliography.* Muséum d'Histoire Naturelle, Geneva.

Lugo, A.E. 1988. Diversity of tropical species: questions that elude answers. *Biology International* Special Issue 19: 1–37.

Mercer, C.W.L. 1997. Sustainable production of insects for food and income by New Guinea villagers. *Ecology of Food and Nutrition* 36: 151–157.

Miller, S.E. 1993. Biodiversity and conservation of the nonmarine invertebrate of Papua New Guinea. Pp. 227–325 in Beehler, B.M. (ed.) *Papua New Guinea Conservation Needs Assessment,* volume 2. Papua New Guinea Department of Environment and Conservation, Boroko.

Miller, S.E. 1996. Biogeography of Pacific insects and other terrestrial invertebrates: a status report. Pp. 463–475 in Keast, A., and S.E. Miller (eds.) *The Origin and Evolution of Pacific Island Biotas, New Guinea to Eastern Polynesia: Patterns and Processes.* SPB Academic Publishing, Amsterdam.

Miller, S.E. 1998. Taxa group summary: insects/terrestrial invertebrates. Pp. 46–47 and map in Burnett, J.B. (ed.) *The Irian Jaya Biodiversity Conservation Priority-Setting Workshop: Final Report.* Conservation International, Washington, D.C.

Miller, S.E., and J.D. Holloway. 1992. Priorities for conservation research in Papua New Guinea: non-marine invertebrates. Pp. 44–58 in Pearl, M., et al. (eds.) *Conservation and Environment in Papua New Guinea: Establishing Research Priorities.* Embassy of Papua New Guinea, Washington, DC, and Wildlife Conservation International, Bronx, New York.

Miller, S.E., and L.M. Rogo. 2001. Challenges and opportunities in understanding and utilisation of African insect diversity. *Cimbebasia* 17:197–218.

Morris, M.G. 1986. A butterfly farming and trading agency in Irian Jaya. Unpublished report on consultancy in Indonesia for World Wildlife Fund and USAID.

Nair, K.S.S. (ed.). 2000. *Insect Pests and Diseases in Indonesian Forests: An Assessment of the Major Threats, Research and Efforts.* CIFOR, Bogor.

Nakamura, M. 1992. An ecological study of earthworms in Papua New Guinea. *Journal of Chuo University* 13: 19–33.

Nakata, S. 1961. Some notes on the occurrence of Phasmatodea in Oceania. *Pacific Insects Monograph* 2: 107–121.

Neboiss, A. 1986. *Atlas of Trichoptera of the SW Pacific-Australian Region.* W. Junk, Dordrecht.

Neboiss, A. 1989. Additions and corrections to the Atlas of Trichoptera of the SW Pacific-Australian region. *Occasional Papers from the Museum of Victoria* 4: 63–67.

New, T.R. 2003. *The Neuroptera of Malesia.* Brill, Leiden.

New, T.R., and N.M. Collins. 1991. *Swallowtail Butterflies: An Action Plan for Their Conservation.* IUCN Gland, Switzerland.

Nishida, G.M., and N.L. Evenhuis. 2000. Arthropod pests of conservation significance in the Pacific: a preliminary assessment of selected groups. Pp. 115–142 in Sherley, G. (ed.) *Invasive Species in the Pacific: A Technical Review and Draft Regional Strategy.* SPREP, Apia, Samoa.

Novotny, V., Y. Basset, S.E. Miller, P. Drozd, and L. Cizek. 2002a. Host specialization of leaf-chewing insects in a New Guinea rain forest. *Journal of Animal Ecology* 71: 400–412.

Novotny, V., Y. Basset, S.E. Miller, G.D. Weiblen, B. Bremer, L. Cizek, and P. Drozd. 2002c. Low host specificity of herbivorous insects in a tropical forest. *Nature* 416: 841–844.

Novotny, V., P. Drozd, S.E. Miller, M. Kulfan, M. Janda, Y. Basset, and G.D. Weiblen. 2006. Why are there so many species of herbivorous insects in tropical rainforests? *Science* 313: 1115–1118.

Novotny, V., S.E. Miller, Y. Basset, L. Cizek, K. Darrow, B. Kaupa, J. Kua, and G.D. Weiblen. 2005. An altitudinal comparison of caterpillar (Lepidoptera) assemblages on *Ficus* trees in Papua New Guinea. *Journal of Biogeography* 32: 1303–1314.

Novotny, V., S.E. Miller, Y. Basset, L. Cizek, P. Drozd, K. Darrow, and J. Leps. 2002b. Predictably simple: communities of caterpillars (Lepidoptera) feeding on rainforest trees in Papua New Guinea. *Proceedings of the Royal Society of London* B 269: 2337–2344.

Novotny, V., S.E. Miller, J. Leps, Y. Basset, D. Bito, M. Janda, J. Hulcr, K. Damas, and G.D. Weiblen. 2004. No tree an island: the plant-caterpillar food web of a secondary rainforest in New Guinea. *Ecology Letters* 7: 1090–1100.

Oosterbroek, P. 1998. *The Families of Diptera of the Malay Archipelago.* Brill, Leiden.

Oppel, S. 2006. Comparison of two Odonata communities from a natural and modified rainforest in Papua New Guinea. *International Journal of Odonatology* 9 (1): 89–102.

Orsak, L.J. 1993. Killing butterflies to save butterflies: a tool for tropical forest conservation in Papua New Guinea. *News of the Lepidopterist's Society* 1993 (3): 71–80.

Owen, I.L. 2005. Parasitic zoonoses in Papua New Guinea. *Journal of Helminthology* 79: 1–14.

Paclt, J. 1982. On some Solomon Islands, Papua New Guinea and Sarawak Thysanura. *Annotationes Zoologicae et Botanicae* 151: 1–10.

Paclt, J. 1985. Diplura from the Bismarck Archipelago and the Solomon Islands. *International Journal of Entomology* 27: 208–211.

Parsons, M.J. 1992. The butterfly farming and trading industry in the Indo-Australian region and its role in tropical forest conservation. *Tropical Lepidoptera* 3 (Supplement 1): 1–31.

Parsons, M.J. 1998. *The Butterflies of Papua New Guinea: Their Systematics and Biology.* Academic Press, San Diego.

Penny, N.D., and G.W. Byers. 1979. A check-list of the Mecoptera of the world. *Acta Amazonica* 9: 365–388.

Pimm, S.L., and J.L. Gittleman. 1992. Biological diversity: where is it? *Science* 255: 940.

Polhemus, D.A. 1996. Island arcs, and their influence on Indo-Pacific biogeography. Pp. 51–66 in Keast, A., and S.E. Miller (eds.) *The Origin and Evolution of Pacific Island Biotas, New Guinea to Eastern Polynesia: Patterns and Processes.* SPB Academic Publishing, Amsterdam.

Polhemus, D.A., and J.T. Polhemus. 1998. Assembling New Guinea: 40 million years of island arc accretion as indicated by the distributions of aquatic Heteroptera (Insecta). Pp. 327–340 in Hall, R., and J.D. Holloway (eds.) *Biogeography and Geological Evolution of SE Asia.* Backhuys Publishers, Leiden.

Polhemus, D.A., and J.T. Polhemus. 2000. A biodiversity survey of aquatic insects in the Ajkwa River Basin and adjacent areas, Irian Jaya, Indonesia. *Tropical Biodiversity* 5: 197–216.

Ponzetta, M.T., and M.G. Paoletti. 1997. Insects as food of the Irian Jaya populations. *Ecology of Food and Nutrition* 36: 321–346.

Price, R.D. 2003. *The Chewing Lice: World Checklist and Biological Overview.* Illinois Natural History Survey, Champaign.

Raven, P.H. (ed.). 1980. *Research Priorities in Tropical Biology.* National Academy of Sciences, Washington, D.C.

Rentz, D.C.F. 1996. *Grasshopper Country: The Abundant Orthopteroid Insects of Australia.* University of New South Wales Press, Sydney.

Ricklefs, R.E., and K. O'Rourke. 1975. Aspect diversity in moths: a temperate-tropical comparison. *Evolution* 29: 313–324.

Riedel, A. 2001. Revision of the simulans-group of *Euops* Schoenherr (Coleoptera, Curculionoidea, Attelabidae) from the Papuan region. *Deutsche Entomologische Zeitschrift* 48: 139–221.

Robinson, M.H. 1969. Defenses against visually hunting predators. *Evolutionary Biology* 3: 225–259.

Roisin, Y., and J.M. Pasteels. 1996. The nasute termites (Isoptera: Nasutitermitinae) of Papua New Guinea. *Invertebrate Taxonomy* 10: 507–616.

Rosariyanto, E., H. van Mastrigt, H.S. Innah, and H. Yoteni. 2002. Butterflies of the Yongsu area, Papua, Indonesia. Pp. 61–62, 138–139 in Richards, S.J., and S. Suryadi (eds.) *A Biodiversity Assessment of Yongsu-Cyclops Mountains and the Southern Mamberamo Basin, Papua, Indonesia.* Conservation International, Washington, D.C.

Ross, E.S. 1948. The Embioptera of New Guinea. *Pan-Pacific Entomologist* 24: 97–116.

Roth, L.M. 2003. Systematics and phylogeny of cockroaches (Dictyoptera: Blattaria). *Oriental Insects* 37: 1–186.

Scheffrahn, R.H., J. Krecek, A.L. Szalanski, J.W. Austin, and Y. Roisin. 2005. Synonymy of two arboreal termites (Isoptera: Termitidae: Nasutitermitinae): *Nasutitermes corniger* from the Neotropics and *N. polygynus* from New Guinea. *Florida Entomologist* 88: 28–33.

Scott, J.M., B. Csuti, J.J. Jacobi, and J.E. Estes. 1987. Species richness: a geographic approach to protecting future biological diversity. *BioScience* 37: 782–788.

Segers, H., and L. De Meester. 1994. Rotifera of Papua New Guinea, with the description of a new *Scaridium* Ehrenberg, 1830. *Archiv für Hydrobiologie* 131: 111–125.

Sekhran, N., and S.E. Miller (eds.). 1996. *Papua New Guinea Country Study on Biological Diversity.* Papua New Guinea Department of Environment and Conservation, Waigani.

Simbolon, K., and A. Iswari. 1990. *Protected Butterflies in Indonesia.* Ministry of Forestry, Republic of Indonesia, Jakarta.

Simon Thomas, R.T. 1962. De Plagen van enkele Cultuurgewassen in West Nieuw Guinea. [Checklist of pests of some crops in West Irian]. *Meded. Econ. Zak.* (Landbouwk. ser.) 1: 1–126.

Sluys, R., and I.R. Ball. 1990. The aquatic triclads (Platyhelminthes, Tricladida) of the Bismarck Archipelago. *Steenstrupia* 16: 13–20.

Smithers, C.N., and I.W.B. Thornton. 1981. The role of New Guinea in the evolution and biogeography of Psocopteran insects. Pp. 621–638 in Gressitt, J.L. (ed.) *Biogeography and Ecology of New Guinea.* W. Junk, The Hague.

Snelling, R.R. 1998. Social Hymenoptera. Pp. 39–47, 131–143 in Mack, A.L. (ed.) *A Biological Assessment of the Lakekamu Basin, Papua New Guinea.* Conservation International, Washington, DC.

Snyder, T.E. 1949. Catalog of the termites of the world. *Smithsonian Miscellaneous Collection* 112: 1–490.

Solem, A. 1984. A world model of land snail diversity and abundance. Pp. 6–22 in Solem, A., and A.C. van Bruggen, *World-wide Snails: Biogeographical Studies on Non-marine Mollusca.* E.J. Brill, Leiden.

Steinmann, H. 1989. *World Catalogue of Dermaptera.* Kluwer Academic, Dordrecht.

Stonedahl, G.M., and W.R. Dolling. 1991. Heteroptera identification: a reference guide, with special emphasis on economic groups. *Journal of Natural History* 25: 1027–1066.

Sturm, H. 1999. Felsenspringer (Meinertellidae, Archaeognatha, Insecta) aus Papua-Neuguinea und Irian Jaya—Beschreibung einer neuen Gattung und drei neuer Arten [Bristle-tails (Meinertellidae, Archaeognatha, Insecta) from Papua New Guinea and Irian Jaya—description of a new genus and three new species]. *Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg* 13 (159): 1–12.

Sturm, H., and R. Machida. 2001. *Archaeognatha.* Walter de Gruyter, Berlin.

Sutton, S.L., and N.M. Collins. 1991. Insects and tropical forest conservation. Pp. 405–424 in Collins, N.M., and J.A. Thomas (eds.) *The Conservation of Insects and Their Habitats.* Academic Press, London.

Takaoka, H. 2003. *The black flies (Diptera: Simuliidae) of Sulawesi, Maluku and Irian Jaya.* Kyushu University Press, Fukuoka, Japan.

Tuxen, S.L. 1964. *The Protura, a Revision of the Species of the World with Keys for Determination.* Hermann, Paris.

Ubaidillah, R. 1991. Hama Penting Pada Beberapa Lahan Pertanian di Wamena Jayawijaya Irian Jaya [The important pests of the agricultural area in Wamena, Jayawijaya, Irian Jaya]. Pp. 25–30 in *Prosiding Seminar Hasil Penelitian dan Pengembangan Sumber Daya Hayati.* Lembaga Ilmu Pengetahuan Indonesia (LIPI), Bogor.

Ubaidillah, R., W.A. Noerdjito, and D. Peggie. 1994. Papilionidae Irian Jaya dan pulau disekitarnya [Papilionidae of Irian Jaya and adjacent islands]. Pp. 463–473 in Pratignjo, S.E., W.R. Farida, and Sunaryo (eds.) *Prosiding Seminar Hasil Penelitian dan Pengembangan Sumber Daya Hayati,* Puslitbang Biologi-LIPI, Bogor, 4 April 1994. Lembaga Ilmu Pengetahuan Indonesia (LIPI), Bogor.

van der Lande, V.M. 1993. Onychophora in New Guinea: a review. *Science in New Guinea* 19: 3–10.

van der Lande, V.M. 1994. Haemadipsid leeches of New Guinea: a review of their biology and a guide to identification. *Science in New Guinea* 20: 9–22.

van Herwaarden, H.C.M. 1998. A guide to genera of stick- and leaf-insects (Insecta: Phasmida) of New Guinea and the surrounding islands. *Science in New Guinea* 24: 55–114.

van Mastrigt, H.J.G., and E. Rosariyanto. 2002. Butterflies and moths of the Dabra area, Mamberamo River Basin, Papua, Indonesia. Pp. 63–66, 140–143 in Richards, S.J., and S. Suryadi (eds.) *A Biodiversity Assessment of Yongsu-Cyclops Mountains and the Southern Mamberamo Basin, Papua, Indonesia.* Conservation International, Washington, DC.

van Mastrigt, H.J.G., and E. Rosariyanto. 2005. *Buko panduan lapangan kupu-kupu untuk wilayah Mamberamo Sampai Pegunungan Cyclops.* Conservation International Indonesia Program, Jakarta.

van Steenis-Kruseman, M.J. 1950. Cyclopaedia of collectors. *Flora Malesiana* ser. I, 1: i–clii, 1–639 (supplements l.c. 5: ccxxxiv–cccxlii, 1958, and 8: 1–115, 1974).

Willemse, L.P.M. 2001. *Guide to the Pest Orthoptera of the Indo-Malayan Region.* Backhuys Publishers, Leiden.

Williams, D.F. (ed.). 1994. *Exotic Ants: Biology, Impact, and Control of Introduced Species.* Westview Press, Boulder, Colorado.

Yeates, D.K., M.S. Harvey, and A.D. Austin. 2003. New estimates for terrestrial arthropod species-richness in Australia. *Records of the South Australian Museum Monograph Series* 7: 231–241.

Yoshii, R., and Y.R. Suhardjno. 1992. Notes on the Collembolan fauna of Indonesia and its vicinities. II: Collembola of Irian Jaya and Maluku Islands. *Acta Zoologica Asiae Orientalis* 2: 1–52.