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Ectoparasites of commensal rodents in Sulawesi Utara, Indonesia, with notes on species of medical importance

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Abstract. Ectoparasite records are presented for four species of commensal murid rodents (*Rattus rattus palelae* Miller & Hollister, *R.argentiventer* (Robinson & Kloss), *R.exulans* (Peale) and *Mus musculus castaneus* Waterhouse) in Sulawesi Utara, with particular reference to the potential for these arthropods to bite and transmit pathogens to humans. The flea, *Xenopsylla cheopis* (Rothschild), was most common on *R.r.palelae* and is capable of transmitting plague and other pathogens to humans although no current foci for these diseases are known in Sulawesi. *Hoplopleura pacifica* Ewing and *Polyplax spinulosa* (Burmeister) sucking lice parasitized all three *Rattus* species although *H.pacifica* was mainly associated with *R.exulans* and *P.spinulosa* with *R.r.palelae*. These lice do not bite humans but may be intramurid vectors of murine typhus and other zoonoses. The mites *Laelaps echidnina* Berlese and *L.nuttalli* Hirst were both collected; the latter was recorded from all four murid species, mainly *R.exulans*. The mite *Ornithonyssus bacoti* Hirst was rare. Only one chigger mite, *Walchiella oudemansi* (Walch), was retrieved from murids (from *R.exulans*) and a single *Leptotrombidium deliense* (Walch) chigger was taken from a human subject. Although *L.deliense* is a significant vector of scrub typhus, a disease known from Sulawesi, the *L.deliense*–*R.argentiventer* relationship frequently noted in the ecology of this rickettsial disease, was not evident in this survey. Other ectoparasites collected from murids were the ticks, *Ixodes granulatus* Supino (first record for Sulawesi), *Haemaphysalis* sp. and *Dermacentor* sp., the mites *Myocoptes musculinus* (Koch) and *Listrophoroides cucullatus* (Trouessart), acarids and a uropodid. Additional ectoparasites noted on humans were the tick *Amblyoma babirussae* (Schulze), the scabies mite *Sarcoptes scabiei* L. and the head louse *Pediculus humanus capitis* De Geer.

Key words. Rats, mice, Muridae, lice, ticks, mites, fleas, scabies, vectors, disease transmission, ectoparasites, Sulawesi, Indonesia.

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Introduction

Although most of the mammalian fauna of Sulawesi is bioendemic, the commensal (anthropophilic) rats and mice present on this island are the same six species that generally occur throughout Indo-Australia in close association with humans or their agricultural and forestry activities, i.e. *Rattus rattus* (L.), *R.norvegicus* (Berkenhout), *R.argentiventer* (Robinson & Kloss), *R.exulans* (Peale), *R.nitidus* (Hodgson) and *Mus musculus* L. (Musser, 1977, 1987; Whitten *et al.*, 1987). This rodent fauna does not appear to be native to Sulawesi and probably colonized the island in association with human settlers 8000–30,000 years ago, or more recently in certain cases (Musser, 1977; Durden, 1986; Whitten *et al.*, 1987). Because of their proximity to humans, the ectoparasites that these rodents harbour are of potential medical importance, particularly with respect to vector-borne disease transmission. Scrub typhus (tsutsugamushi fever or chigger-borne rickettsiosis) which is transmitted by ectoparasitic chigger mites of the *Leptotrombidium* (*L.*) *deliense* (Walch)-group has been previously reported from Sulawesi (Hadi *et al.*, 1979) and other ectoparasite-borne human pathogens may be isolated with further study.

Except for brief mention by Van Peenan *et al.* (1974) and Durden (1986), the ectoparasite fauna of commensal rodents in Sulawesi has not previously been documented. The purpose of this study is to report on the ectoparasites collected from four species of commensal rodents in Sulawesi Utara (North Sulawesi) during the Royal Entomological Society's Project Wallace expedition (Knight & Holloway, 1990), to compare the results with other commensal rodent ectoparasite surveys in the Indo-Pacific Region and to comment on any ectoparasite taxa that may be medically significant. A brief report on some ectoparasites collected from humans is also included.

Materials and Methods

Commensal rodents were live-trapped in, or close to, human settlements from February to July 1985 in Sulawesi Utara. Most rodents were collected near Dumoga (0°34′N, 123°53′E) at about 200 m elevation. In addition, two *Rattus rattus palelae* Miller & Hollister and one *Mus musculus castaneus* Waterhouse were secured in a building at about 1200 m on the slopes of Gunung (Mount) Moajat (0°45′N, 124°29′E), approximately 60 km to the northeast. Except for one particular specimen of flea, the ectoparasite faunas from rodents at these two sites were not significantly different and data from them have been combined in the analyses that follow.

Trapped rodents were euthanized. Ectoparasites were retrieved from each animal firstly by vigorously brushing the fur over a white tray to dislodge arthropods and then by meticulously searching through the pelage with fine forceps and probes. Collected ectoparasites were stored in 70% ethanol until they could be cleared (in potassium hydroxide or lactophenol) and slide-mounted (in Canada balsam or Hoyer's medium) for microscopical identification, as needed.

Ectoparasites were also collected from a small number of consenting human subjects by visual examinations.

Results

A total of thirty-nine commensal rodents comprising four species; *R.rattus palelae*, *R.argentiventer*, *R.exulans* and *M.musculus castaneus*, was collected. The ectoparasites retrieved from these rodents are documented in Table 1 with respect to infestation prevalences and intensities following Margolis *et al.* (1982).

Two flea species (Siphonaptera) were taken: the pulicid *Xenopsylla cheopis* (Rothschild) (13♂, 17♀) one of only two ectoparasite species collected from all four rodent species, and a single female specimen of a new genus and species of pygiopsyllid flea that is also known by other undocumented material from forest rats in Sulawesi (Robert Traub, personal communication). *Xenopsylla cheopis* was collected most frequently from *R.r.palelae*.

Two species of sucking lice (Anoplura) were collected. Both *Hoplopleura pacifica* Ewing (Hoplopleuridae) (forty specimens comprising 5♂, 19♀, four third instar nymphs, nine second instars and three first instars) and *Polyplax spinulosa* (Burmeister) (Polyplacidae) (fourteen specimens comprising 2♂, 10♀, one third instar nymph and one first instar) were collected from all three *Rattus* hosts but not from *M.musculus castaneus*. *Hoplopleura pacifica* was particularly common on *R.exulans*.

Table 1. Ectoparasite infestations of commensal rodents in Sulawesi Utara in 1985. Figures refer to prevalence (% infested) and mean intensity (mean number per host), respectively, following Margolis *et al.* (1982).

	Host			
Ectoparasites	*Rattus rattus palelae* (n=13)	*R.argentiventer* (n=12)	*R.exulans* (n=8)	*Mus musculus castaneus* (n=6)
Siphonaptera				
Xenopsylla cheopis	46.2%, 1.8	25.0%, 0.3	12.5%, 0.1	16.7%, 0.3
N.gen., n.sp.	7.7%, 0.1	–	–	–
Anoplura				
Hoplopleura pacifica	23.1%, 1.2	16.7%, 0.3	37.5%, 2.6	–
Polyplax spinulosa	15.4%, 0.7	16.7%, 0.3	12.5%, 0.1	–
Acari				
Ixodes granulatus	7.7%, 0.5	–	–	16.7%, 0.3
Haemaphysalis sp.	–	–	12.5%, 0.1	–
Dermacentor sp.	–	–	12.5%, 0.1	–
Laelaps echidnina	46.2%, 0.9	25.0%, 0.3	50.0%, 0.5	–
Laelaps nuttalli	23.1%, 0.7	33.3%, 0.5	50.0%, 4.0	16.7%, 0.2
Ornithonyssus bacoti	15.4%, 0.2	–	–	–
Myocoptes musculinus	–	–	–	16.7%, 0.2
Listrophoroides cucullatus	15.4%, 0.2	–	–	–
Walchiella oudemansi	–	–	12.5%, 0.1	–
Acaridae	15.4%, 0.2	–	–	–
Uropodidae	7.7%, 0.1	–	–	–

Three species of ixodid ticks (Acarina: Ixodidae) were taken. *Ixodes granulatus* Supino (1♀, eight larvae) infested *R.r.palelae* and *M.musculus castaneus* while single specimens of *Haemaphysalis* sp. (one larva) and *Dermacentor* (*Indocentor*) sp. (one nymph), that could not be identified to the species level because of their immature status, were taken from only *R.exulans*.

Of the Arachnida, congeneric laelapid mites *Laelaps* (*Echinolaelaps*) *echidnina* Berlese (2♂, 18♀) and *L.*(*L.*) *nuttalli* Hirst (10♂, 32♀, six nymphs) were both collected from all three *Rattus* hosts; another single *L.*(*L.*) *nuttalli* nymph was collected from a *M.musculus castaneus* individual. *Laelaps* (*L.*) *nuttalli* was particularly common on *R.exulans*.

The macronyssid mite *Ornithonyssus bacoti* (Hirst) was represented by just two female specimens, one each from two *R.r.palelae* hosts. Similarly, the myocoptid mite *Myocoptes musculinus* (Koch) was collected only once, as a female specimen taken from *M.musculus castaneus*. The fur mite *Listrophoroides cucullatus* (Trouessart) (1♂, 2♀) was recorded only from *R.r.palelae* and the only chigger mite (Trombiculidae) retrieved, *Walchiella oudemansi* (Walch), was represented by a single larva from *R.exulans*. Two acarid mites (phoretic deutonymphs) and a single female uropodid mite, all collected from *R.r.palelae*, cannot be identified further.

Ectoparasites collected from humans were as follows: (1) Thirty-one *Amblyomma babirussae* (Schulze) ixodid ticks (all larvae) taken from the ankles of a male subject on 28 August 1985 at Dumoga. (2) One *Leptotrombidium* (*L.*) *deliense* (Walch) chigger (larva) taken from the leg of a female subject on 20 July 1985 at Dumoga. Many other cases of chigger bites were suspected by other humans in the same area but specimens were not obtained. (3) *Sarcoptes scabiei* L. mite infestations (Sarcoptidae) were fairly common epidermal/dermal complaints in some local Indonesians. Known cases were treated by expedition medical teams. (4) *Pediculus humanus capitis* De Geer head lice infestations (Pediculidae) were also fairly common on local Indonesians, particularly children.

Discussion

The four species of commensal rodents that were collected in this survey are all fairly common throughout much of Sulawesi in association with human activity. Two other commensal species that were not taken, occur only at high elevations in Central Sulawesi (*R.nitidus*) or have only been recorded from sea ports (*R.norvegicus*) (Musser, 1987). The host rodent species surveyed in Sulawesi Utara also occur elsewhere in the Indo-Pacific Region (and beyond, in most cases) and comparisons can be made with available ectoparasite data concerning them within this region.

Most of the ectoparasites recorded here from commensal rodents are species that are typically associated with such hosts. This applies to all the arthropod species except the ticks, the uropodid mite and the new genus and species of flea; other undocumented specimens of this flea reveal that it is normally parasitic on native forest rats in Sulawesi and that the single specimen reported here from *R.r.palelae* represents a straggler. With respect to the ticks, the records of *I.granulatus* are the first documented for Sulawesi, although this tick is well known throughout much of Southeast Asia including most of Indonesia and the Philippines (Anastos, 1950; Kohls, 1950; Kadarsan, 1971) and is probably also widespread in Sulawesi. Uropodid mites are known to be phoretic on fleas (Schwan & Corwin, 1987) and other arthropods (Krantz, 1978) so the present material could feasibly have been dislodged from ectoparasites.

Xenopsylla cheopis fleas were most frequent on *R.r.palelae*. Other surveys that have found *R.rattus* to be the principal host for this flea include those by Van Peenan *et al.* (1974) for Central Sulawesi, Hadi *et al.* (1976, 1983), Liat *et al.* (1980b) and Kadarsan *et al.* (1986) for Java, and Mitchell *et al.* (1966) for India. However, *Xenopsylla cheopis* also parasitizes other *Rattus* spp. and *M.musculus*, as found in this survey, and readily bites humans. This flea is the classic vector of plague (*Yersinia pseudotuberculosis pestis* (Lehmann & Neumann)) and, although this disease is not presently known from Sulawesi, potential vectors obviously exist there. In addition to plague, *X.cheopis* is capable of transmitting the agents of murine (endemic) typhus (*Rickettsia typhi* (Wolbach & Todd)) (Traub *et al.*, 1978) and tularaemia (*Francisella tularensis* (McCoy & Chapin)) between rats and humans, and of acting as an intermediate host of tapeworms such as *Dipylidium caninum* (L.) and *Hymenolepis* spp. Between rats, *X.cheopis* is a vector of *Trypanosoma lewisi* (Kent) and other pathogens (Blackmore & Owen, 1968).

The two species of sucking lice collected in this survey were disproportionately represented on the four murid species. While no lice were collected from *M.musculus castaneus*, all three *Rattus* hosts were infested by both louse species. *H.pacifica* was more abundant on *R.exulans* and *P.spinulosa* showed a slight preference for *R.r.palelae* as evidenced by infestation intensities. These trends agree with most other louse surveys of domestic *Rattus* in the Indo-Pacific Region, e.g. Mosby & Wodzicki (1972), Wilson & Wodzicki (1977), King *et al.* (1980), Tenorio & Goff (1980) and Hadi *et al.* (1983). Although these two louse species may utilize different *Rattus* hosts, they do not parasitize humans and consequently pose no direct medical threat (Kim *et al.*, 1986). However, they are known or suspected to transmit zoonotic pathogens from rat to rat and these could ultimately be transmitted to humans by other haematophagous arthropods that do bite humans. Thus, *P.spinulosa* can transmit murine typhus between rats (Kim *et al.*, 1973, 1986) and Traub *et al.* (1978) report that rat lice (*Polyplax* and *Hoplopleura*) have been found to be naturally infected and capable of experimental transmission of *R.typhi*; they should therefore be considered as potential intramurid vectors, and perhaps also as possible sources of transmission to humans via the aerosol route (by inhalation of dust from infected louse faeces). Between rats, *P.spinulosa* is a natural vector of murine haemobartonellosis and an experimental vector of louse-borne (epidemic) typhus, *Rickettsia prowazekii* Da Rocha-Lima (Kim *et al.*, 1973). The related sucking louse, *P.serrata* (Burmeister), which was not collected during this survey, is a natural vector of murine erythrozoonosis (Kim *et al.*, 1986).

Laelaps (*E.*) *echidnina* and *L.*(*L.*) *nuttalli* are well-known domestic rat and mouse ectoparasites throughout most of the world's tropical, subtropical and temperate regions. They frequently occur on the same host individual, but the smaller *L.*(*L.*) *nuttalli* is usually the more abundant species (Tenorio & Goff, 1980); in this study *L.*(*L.*) *nuttalli* was prevalent on *R.exulans* and *L.*(*E.*) *echidnina* slightly more prevalent on *R.r.palelae*. Similar host preferences of *L.*(*L.*) *nuttalli* have been noted by Mitchell (1964a, b), Radovsky *et al.* (1979) and Tenorio & Goff (1980) in Hawaii, Wilson (1967) in Micronesia, Allred (1969) in New Guinea and Hadi *et al.* (1983) in Java. Typically, neither of these mite species breaks intact host skin, but instead locates previously abraded or damaged areas in order to imbibe blood (Mitchell, 1964a; Yunker, 1973). Despite this seemingly less efficient feeding technique, both species will readily attack humans, if available, and they must therefore be considered as potential vectors of several agents. Between rats, *L.*(*E.*) *echidnina* is capable of transmitting the lethal apicomplexan *Hepatozoon muris* (Balfour) (Telford *et al.*, 1980) and Junin virus, the aetiological agent of Argentinian Haemorrhagic Fever (Yunker, 1973). Also, both mite species could play a role in murine typhus and Seoul virus epidemiology (Cole & Koepke, 1946; Traub *et al.*, 1978; Arikawa *et al.*, 1989).

Ornithonyssus bacoti, the tropical rat mite, was rare in this survey but has public health significance since it readily bites humans, often resulting in tropical rat mite dermatitis (Yunker, 1973; Tenorio & Goff, 1980). This mite is almost cosmopolitan in distribution and frequently infests domestic rats in much larger numbers than observed in Sulawesi Utara. *Ornithonyssus bacoti* is capable of harbouring and transmitting the causative agents of murine typhus, rickettsialpox (*Rickettsia akari* Huebner, Jellison & Pomerantz), Q fever (*Coxiella burnetii* (Derrick)), plague and tularaemia, but it is not an important natural vector of any of these (Yunker, 1973; Tenorio & Goff, 1980). This mite has been reported also to harbour Eastern Equine Encephalitis, Hantaan and Coxsackiae viruses. Between cotton rats, *O.bacoti* is the principal vector of the filarial nematode *Litosomoides carinii* (Travis) (Yunker, 1973; Tika Ram *et al.*, 1986).

The other ectoparasites collected from rodents during this survey were either rare, not truly haematophagous, or are otherwise considered to lack significant vector competence for pathogens. Nevertheless, the ticks and other blood-sucking species have considerable potential for pathogen transmission and, with further study, this may prove to be the case.

The ectoparasites recorded from *Rattus* hosts in this survey are mostly widespread species; additional taxa, particularly mites, will probably be secured from such hosts in future Sulawesi surveys. The situation for *M.musculus castaneus* was somewhat different however. On the six mice examined, no lice such as *P.serrata* or *Hoplopleura captiosa* Johnson, nor fleas such as *Leptopsylla segnis* (Schönherr) were collected. Similarly, a number of parasitic mites that frequently occur on *M.musculus* were not represented. Further collecting should resolve whether these species are actually part of the ectoparasite fauna of mice in Sulawesi, as would be expected, or whether they are absent from this island.

The small samples of ectoparasites collected directly from humans are of interest. The tick *A.babirussae* is bioendemic to Sulawesi and normally parasitizes large mammals. Six *A.babirussae* specimens (5♂, 1♀) were documented from humans in Sulawesi by Keirans & Robbins (1987). The present record of thirty-one *A.babirussae* larvae from one person shows that immature stages of this tick also attack humans.

Leptotrombidium (*L.*) *deliense*-group chiggers are implicated as vectors of scrub typhus, *Rickettsia tsutsugamushi* (Hayashi), throughout much of the Indo-Pacific Region. Although only one larval chigger was collected from humans in this survey, the specimen was *L.*(*L.*) *deliense*. This is significant because scrub typhus has previously been reported from Sulawesi (Hadi *et al.*, 1979) and because numerous expedition members claimed to have been bitten by chiggers; many of them suffered typical lesions, although specimens were not retrieved. Also, *L.*(*L.*) *deliense* was recorded from native forest rats in the same area of Sulawesi by Durden (1986) and Whitaker & Durden (1987). Traub & Wisseman (1974) showed that in Malaysia *L.*(*L.*) *deliense* and *R.argentiventer* predominated in scrub typhus ecology for up to 3 years following habitat disturbance, but that other chigger and rat species became involved in the cycle as lalang grass appeared and termites (which are food sources for *R.argentiventer*) became scarce. Similarly, *L.*(*L.*) *deliense* and *R.argentiventer* have been implicated as principal components in scrub typhus ecology on Java by Liat *et al.* (1980a, b) and Hadi & Sarbini (1985). Although *R.argentiventer* was common in disturbed vegetation in Sulawesi

Utara, no chiggers were collected from this murid. In fact, only one chigger (*W.oudemansi*) was collected from all thirty-nine murids combined. This situaton does not appear to be related to collection error, since mites smaller than chiggers were consistently retrieved and chiggers were very apparent on forest rats during the same expedition. Bearing these data in mind, it will be interesting to decipher the ecology and epidemiology of scrub typhus on Sulawesi, particularly if future outbreaks occur there.

Both *S.scabiei* burrowing mites and *P.humanus capitis* head lice appeared to be fairly common arthropod parasites of people living in Sulawesi Utara. Although both these ectoparasites (particularly *S.scabiei*) can be deleterious, neither is implicated in pathogen transmission. Further collections in Sulawesi will undoubtedly produce additional ectoparasite species from humans.

Although the results obtained in this study are similar in many respects to situations in other Indo-Pacific regions that harbour the same murid species, some significant differences are apparent. The lack of certain ectoparasites, especially on *M.musculus*, the scarcity of *O.bacoti* and chiggers, and the new records for *I.granulatus* on Sulawesi, are all noteworthy phenomena for the murids. The implication of *A.babirussae* as a parasite of humans and the seemingly unusual infestation nature of chiggers that are potential vectors of scrub typhus are also interesting features that invite further investigations.

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