Laurentella, a new subgenus of Trombiculid Mites, with notes on biology and medical importance

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Euschöngastia indica (Hirst 1915), described from a bandicoot rat' from Calcutta, was shown during World War II to be extremely widespread in south-east Asia. It is the commonest, and often the sole, trombiculid mite to be found on house-rats, roughly in the area bounded by India, Sumatra, New Guinea, Guam and Philippines. Recent collections have shown that this is a member of a fairly large group, and the 'indica-group' (Womersley 1952:237; IMR 1953:65) was provisionally discussed as 'new subgenus' of Euschöngastia by Audy (1954b:154). It is now possible to distinguish this group from some related groups showing convergence in the larvae. The group shows characters which distinguish it at least at a subgeneric level from the type, Schöngastia scuricola Ewing 1925, of the genus Euschöngastia; it is therefore here described as a new subgenus.

The subgenus has considerable biological interest because of the occurrence of one species (E. indica) as a widespread urban chigger, and of another (E. audyi) as the dominant chigger on tree-living mammals in the Malay Peninsula: while some species are endoparasitic in the nasal cavities of rodents. It is of great taxonomic interest because, together with the genera Ascoschöngastia and Pseudoschöngastia, it appears to form part of a complex involving a number of controversial characters. The biology of the group and its potential medical importance are discussed below.

Genus Euschöngastia Ewing, sensu lato

Laurentella new subgenus


Diagnosis*.—Those trombiculid mites described as the 'indica-group' by Audy 1954b:154) which have hitherto been included in the genus Euschöngastia Ewing 1938, after Wharton & Fuller 1952:73, but are distinguished in the larval stage by possessing the following characters: Scutum small subquadrate, lightly cutinized, with AW 20–50; and AP 20–35; in the typical group (i.e. excluding debridus-group), AM is anterior to ALs with the shoulders of the scutum prominent and rounded in front of ALs; AL setae shorter than AM, PLs usually longest; anterior scutal margin usually sinuous.

* The bandicoot rats, Bandicota (Neoba or Gigantomys of many authors), are rodents of the Oriental region and must be distinguished from the marsupial bandicoots of Australasia (e.g. Echymipera, Isoodon). According to Blanford in the Fauna of British India, the term bandicoot is of Indian origin, from the Telugu word karka ('pig rat'), given by hook-diggers, and is consequently correctly applied to the rat rather than the marsupial.

† Account has been taken of some undescribed species in framing this. Standard abbreviations are used, as follows: AL, AM = anterolateral, intermedial scutal setae; SB = sensillary bases or line between them; ASL = anterior scutal length in nymph or adult, from level of SBs to teatial setae, roughly equal to length of cista.

posterior margin convex may be flattened or indented in the midline; sensillary bases about centrally placed, little more than their diameter apart; sensillae expanded but only occasionally globose; in the debilis-group the AM setae is in line with or posterior to the line of ALs and the anterior scutal margin is slightly sinuous and without AL shoulders, and the posterior margin is concave. Eyes 2+2, 1+1, or apparently absent. Gnathosoma: palp setae not strongly developed, with a few small barbs or nude, the femoral seta being appreciably shorter than either genual or dorsal tibial; palpul claw 2- or 3-pronged, modified especially in endoparasitic forms so as to be basally thick and strongly incurved (cf. claws of Dolothisa); chelicerae also variable, occasionally modified in endoparasitic forms so as to be reduced and with a blunt dorsal tooth (cf. Dolothisa); genual setae typically nude, but with a few barbs in the debilis-group. The palpul tarsus bears the usual tarsal plus 6 ordinary setae (5 in debilis-group), one of which may be nude (in debilis-group and some intraspecific species); the subterminal solenidion is absent.

Legs short, especially leg II, with relatively thick stumpy segments; segmentation 7.7.7 although the division of the femora especially of leg II is frequently indistinct: leg III with genua and tibia, and often with one or more nude setae (mastitarsalia), tibia and tarsus of leg III in the intraspecific TAA-group enlarged (thickened) and with an exaggerated modified seta near the pretarsus. Setae of scutum, palps, body, and legs delicately barbed or nude, not stout or plumose, and broadly related to the general degree of chitinization; all setae on body, legs, scutum, and galea more strongly developed and barbed in the debilis-group. Larvae of intraspecific forms showing slight constriction of the body when engorged; preferring mammals and especially rodents in forest, but may be found casually on birds; occasionally endoparasitic (intranasal). Distinguished from larvae of subgenus Helenicola Audy by the presence in the latter of SLs less than their diameter apart and ratio PW/SB over 5 (under 4 in Launenellia). AM shorter than ALs or subequal and its base not anteriorly placed, and with tarsala and microtarsa I subterminal (closer to subterminala), and the 2 tibialae also being placed distally, roughly in a line with the microtibiala. Distinguished from larvae of Arcochongiastus Ewing, sens. str., and Pseudochongiastus Lipovsky by the placing of the PL setae on the scutum. Distinguished from larvae of Dolothisa Ouds., sens. lat., by the 3 (not 2) genua I, the presence of a tibiala III and of AL shoulders on the scutum.

Nymphs and Adults (so far described only for indica, audyi; but known for 5 other species including intraspecific forms, from Malay and Borneo) apparently not distinctive, of general Euchonchiastus facies with ASL:SB ratio almost 2; sensillae generally well-barbed or plumose distally, with well-developed shafts (thickened in audyi). (Studies of postlarval stages are not yet sufficiently advanced for useful comparisons to be made).

Distribution so far known, essentially Oriental and Australasian, extending to Ethiopian region (one species, undescribed) and to Palaeartic (one species in Japan).

Remarks.—The writer has pleasure in naming this subgenus for Dr. R. F. Lawrence, Director of the Natal Museum, South Africa, who has pioneered the proper study of African trombiculids and to whom he is very grateful for the most friendly collaboration in the study of African material.

The subgenus as here envisaged takes account of some material which is to be described in collaboration with Traub in future issues of "Malayan Parasites", continuing “Malayan Parasites I–XV” (Stud. Inst. med. Res., Malaya, 26, 1953, issued
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1954). Sufficient details are here described or drawn to explain emendation of the diagnosis, while the opportunity is taken to give some comparative details of E. rattus, E. debilis, and E. sp. nr. labiamenta (Fig. 1). Euschöningastia debilis represents an atypical species-group described below and provisionally included in this subgenus: it appears to provide a link with the genus Pseuduschöningastia.

The monograph on the type-species, E. (L.) indica, by Wharton (1946) is one of the most complete accounts of any species of trombiculid yet published.

List of Species

The following species are here placed in this subgenus. Data already given in the excellent checklist of Wharton & Fuller (1952:40) are brought up to date and some comments added. Their indications of the type of contributions made by the papers concerned are used again here in the hopes that other compilers of checklists will do the same; these indications are: a—anatomy, b—biology, m—medical, t—taxonomy, v—veterinary, to which we add s—synonymized, l—in a checklist, and N.A.—nymph, adult discussed.

Ellerman (1949) and Ellerman & Morrison-Scott (1951) are taken as the authority for names of host-species in the following list, the names of hosts as actually recorded by authors being shown in parenthesis after the currently accepted name.

New records are added particularly from the following collections, summarized in Audy (1954a): (1) MALAYA, 1948 onwards: by Colonial Office Scrub Typhus Research Unit, described in detail by Audy & Harrison (1954), where also other collections are referred to. (2) BORNEO—SARAWAK 1950–1952; largely by the above unit with Tom Harrison, Government Entomologist and Curator, Sarawak Museum, for whose hearty collaboration we are very grateful, and also by an expedition into the interior in 1950 with the added collaboration of the U.S. Army Medical Research Unit in Malaya (Traub). (3) BORNEO—NORTH BORNEO, expeditions in 1951, 1952, 1953; jointly by U.S. Army and Colonial Office Unit teams with U.S. Army financial support, as described by Traub & Audy (1954a). (4) INDIA: by Lt.-Colonel Sardari L. Kalra, including the collections described by Womersley (1952), which were registered, mounted, and sorted by us, selected series being sent to Womersley. (5) THAILAND: A collection from Thailand has been made through the co-operation of Robert E. Elbel of the U.S. Special Technical and Economic Mission to Thailand, and through the offices of the Thai Division of Communicable Diseases, particularly Dr. Pramaw Chandavimol, Chief of the Division, and Dr. Mall Thaiaunda, Director of the Banpong Plague Laboratory. The records of E. Audy from Thailand in this paper, relating to specific hosts, have kindly been provided by Lt.-Colonel Robert Traub, to whom the writer is also grateful for a number of records from Borneo. Unidentified hosts recorded for E. indica from Thailand are derived from an early collection from near Bangkok sent to us, of which host identities have not yet been checked. (6) HONG KONG, 1949–50: by J. D. Romer, Municipal Rodent Control Officer.

A. Euschöningastia indica species-group

1. Euschöningastia (Laurentella) indica (Hirst)

Type-species of subgenus; type in British Museum (Nat. Hist.) London.

Schöningastia indica Hirst, 1915:187(d); Welsch 1927; Genter 1941; Finnegan 1945; Wharton 1946; Carver 1946; Thor & Willmann 1947; Fuller 1948; Gibson 1950a,b (in).

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Fig. 1. Details of species of *Laurentella*. **ER** (after Domrow)—*Euchroicista (Laurentella) ratti* (Womersley & Headly) (index-group), scutum redrawn to scale from a drawing by Mr. R. Domrow, of a specimen of *ratti* from *Rattus auritus*, Mt. Glorious, South-east Queensland, 6.viii.1951. **ED**—*Euchroicista (Laurentella) debilis* (Gater) (deblis-group), scutum and eyes, specimen from a Crotalaria forest at Belangor. **ET**—*Euchroicista (Laurentella) "TAA"* (TAA-group), scutum, eye, palpal claw and tarsus, chelicer, and part of leg II. The elongate sensilla, short curved palpal claw, and toothed chelicer resemble the same parts of *Debilis*, but other species provide intermediate links with typical *Laurentella*. The inflated tarsus and tibia III is observable as a tendency in other species in the debilis- and index-groups (deblis also has tarsus 3 subglobular).
Schönsteina indica. Toorney, 1921:666(1).

Neoschönsteina indica. Gater, 1932:156(c,1); Gunther, 1941; Heatly, 1941; Radford, 1942; Womersley & Heatly, 1943: Blake et al., 1945; Ruttendijk, 1945; Finnegan, 1945; Taylor & Murray, 1953; Wharton, 1946; Wharton & Carver, 1946; Mohr, 1947; Gunther, 1922:26(1).

Aeschönsteina indica. Wharton, 1946:151-84(ab,cl); Philip & Woodward, 1946; Griffiths, 1947; Jenkins, 1950; Bancroft, 1949(a); Lipovski, 1950.

Euschönsteina indica. Fuller, 1938:107(t); Andy, 1946(1); 1953:154(t); Philip et al., 1949; Philp & Traub, 1950; IMR 1950:64(1); 1952:28(c); IMR 1953:65; Wharton & Fuller, 1953(1); Andy, Thomas & Harrison, 1953(1); Traub & Andy, 1954:67(m); Traub & Evans, 1954:103; Harrison, 1954:181(1), 1956:264; Radford, 1954:266.


Schönsteina (Aeschönsteina) indica. Womersley, 1952:208(d); 378(ND,sc); 2c (corrigeendum).

Trombicula maris, Walch. 1922:74(d). 1923: Fletch et al., 1928(d); Hayakawa & Hokari, 1946; Hayakawa et al., 1944. (Synonym of E.L.) indica homonym of Trombicula (Neorhabdula) indica (Oudem.).


Neoschönsteina maris, Radford, 1942:76(1), 1946.


Aeschönsteina cockingsi, Ewing 1946.


Aeschönsteina Menauli, Andé, 1954(d); Le Gac et al., 1954(d). New synonym.


New Records.—The following records for E. indica (and also, below, for E. australi) are hitherto unpublished. Casual hosts, only occasionally and lightly infested, are shown in parenthesis. Some details of infestation in Malaya are given by Andy & Harrison (1954:17, Table 3). MALAYA: The most heavily infested animal so far found is the semi-arboreal Rattus rattus jolens from a mature oilpalm estate, with nearly 40 miles per rat (though this same species in the forest fringe has many fewer, averaging 3 per rat in our collections, but with a higher proportion of australi); next are domestic rats in towns and villages including Singapore, Kuala Lumpur, Klang, Port Swettenham.
and Port Dickson, both _R. diardii_ and (in certain seaports) _R. norvegicus_, with 10–20 miles per rat; then the squirrel _Callosciurus vittatus_ (about 10 per squirrel, but see section on biology, below) in secondary forest or forest fringes; in small numbers on _Rattus exulans_ and the tree-rat _R. montiventer_, and on tree-shrews, _Tupaia gris_ and _T. minor_. (Also recorded from _R. rattus argenteoverte_._, _R. euramalai_., _R. bowersi_, _R. canus_, _R. milleri_, _R. sabanius_, _R. whiteheadi_, _C. notatus_, _C. caniceps_, _C. lori_, _C. nigrovittatus_; domestic civet, _Paradoxurus histrionicus_; slow loris, _Nycticebus coucang_; and a single specimen taken on two occasions on the giant pill-millipede, _Sphaerothaerus globosus-nigerius_ Jeckel from an aboriginal village, Dusan Wani, Bukit Lanjan Forest Reserve, Selangor—these millipedes were mostly found round rotten logs and were freely infested by _Sieca subarea_ Audy, 1956, and the infestation by _indica_ was obviously by stragglers, probably from some nearby rat's nest. The first record from a millipede was reported by Audy (1950). BORNEO—(a) NORTH BORNEO: Only on _R. diardii_ in and near houses in Jesselton (coast) and Bandu Tuhan (Kinabalu area). 1951–54. Not collected in the uninhabited area of Mt. Trus Madi east of Keningau. 1954. (b) SARAWAK: In moderate numbers on _R. diardii_ and _R. jaluensis_ (Also recorded on _R. whiteheadi_; _C. notatus_; _C. prevosti_ from Kuching area). HONG KONG: On _R. norvegicus_ from town, 1949–50. THAILAND, neighbourhood of Bangkok: common on many animals. All hosts have not been identified but _indica_ has been identified in collections sent by R. Ebel from rodents, _Bandicota indica_ and _B. heigalensis_ (a new record of this host, Harrison 1956). _Rattus rattus_ subsp., "field rats", "ground squirrels" (including _Menetes bairdii_), "grey squirrel", "tree squirrel" (including _C. nigrovittatus_; from insectivores, "shrew", "tree-shrew" (_Tupaia_); and from carnivores, "civet cat", "mongoose" (_Herpestes_). INDIA—(a) MADRAS (Imphal area): _R. r. bullocki_ from in and near villages (Audy et al., 1953) (also on a _Tupaia gin_ and a mongoose, _Herpestes sp._). (b) PENINSULAR INDIA: House-rats from Bombay, Mysore City, Jubbulpore, Bangalore, Mendar, and Sundarbani; shrew (probably _Suncus murinus_). (c) SINDH (formerly Kauria, collection sent to the writer). INDIAN OCEAN, CAR NICOBAR: 22 specimens on 2 of 5 rats, dark-bellied form of _R. rattus_, village 'store', x 1950 (C. A. Gibson-Hill coll.). see IMR 1952:47.

Remarks.—Dr. Marc André sent the writer specimens of his species _montei_ from Saigon. These fall within the range of variation of _E. indica_ and _Aeschongiastis montei_. André is therefore considered here to be a synonym of _E. indica_. _E. indica_ may well be a polytypic species and several published forms may prove to be subspecies: judgement must however be reserved, e.g., in the case of _E. (L.) rattus_, below.

2. _Euschongiasta_ (Laurentella) _audyi_ (Womersley)


_Euschongiasta audyi_, IMR 1952:30(c): Audy et al., 1954, Traub & Audy, 1954:77(m), 811(o).

Remarks.—First collected from towns in South Burma, where it occurred in small numbers on rats, this species has since been found a dominant chigger on arboreal mammals, especially squirrels, in the rain forest of Malaya and Borneo. The larva is orange-red in colour (that of _typica_ is white). Womersley (1952:205) gave
the type data as follows: "Loc. and Host. Described from the type, from Prome, S. Burma, 1945 (no host and further date recorded) and from 6 paratypes from Rattus norvegicus [sic] from R.G.N. Pagoda Rd., S. Burma, 14-16 Sept., 1945 (coll. T. J. Lawrence, type PII, paratypes 702-4, 706-4, 708-1). Also 7 specimens from R.r. norvegicus from Toungoo, S.B. 23 Oct., 1945 (768)". There are confusing errors here partly corrected by Womersley on his p.2a. The correct data, from our records (J.R.A.) are as follows: Described from the type, from Rattus rattus khyensis Hinton, Prome, S. Burma, 29.ix.1945; 6 paratypes from same host species, Pagoda Rd., Rangoon 14-16.ix.45; also 7 specimens from same host, Toungoo, 23.x.1945 (G. W. Ash & J. R. Audy coll.). The collection was part of a survey of South Burma, an account of which is still to be published (details are at present available only in Audy 1947, and to some extent in Audy et al., 1953).

Traub et al. (1950) recovered Rickettsia tsutsugamushi, the infective agent of scrub typhus, from forest chiggers which were provisionally identified and cited as E. indica, but which were subsequently identified with E. audyi.

Previous Records.—SOUTH BURMA: Rattus r. khyensis. MALAYA: Callosciurus nigrovittatus, C. notatus, from forest.

New Records (see comments under E. indica).—MALAYA: Dominant in the forest on squirrels, C. nigrovittatus (about 40 mites per squirrel), C. notatus & C. tenus (10-15 mites); and in small numbers (1-5 per animal) on C. caniceps; on tree-shrews, Tupaioides glis & T. minor; on tree-rats, R. comus, from forest and R.r. jolorensis from forest fringe. (Also recorded on R. aujaudiei, R.r. argentiventer, R.r. diardii, R. roylei surifer, R. sabaunes, C. livii, ground-squirrels Lasius angustus and Rhinocricus latreillei; insectivore, Hylomys sulphus, flying-lemur, Cynocephalus variegatus). BORNEO.—(a) NORTH BORNEO: In largest numbers on squirrels, C. notatus (especially from Kabajang, coastal village in Beaufort area; and in Beaufort area), C. adamsi (especially at Mt. Trus Madi, near Keningau, recorded as Ulu Kaingan). (Also recorded from squirrels, Callosciurus prevosti, C. livii, Dreomomys everetti, Nannosciurus whiteheadi, and the tree-shrew Tupaioides tana, from the Kinabalu and/or the Trus Madi areas, by the joint U.S. expedition). (b) SARAWAK: In largest numbers on a few squirrels collected upcountry, viz. C. notatus, C. prevosti. (Also on R.r. argentiventer, R. milleri, R. whiteheadi, C. notatus, C. prevosti; Nannosciurus whiteheadi; and Tupaioides minor, T. tana, in the Kuching area). THAILAND, Bangkok area: Rattus r. thai from Muang Lampaya (37 from 4 rats) 24.vi.1952, and Ban Pong, and Pakrad, vi.1952; Rattus rattus ssp. from the City (Nakhon Ratchasima district) 11.viii.1952 (this urban occurrence was noted by the writer in Burma but is uncommon in Malay among urban rats in large towns); Callosciurus spp., C. notatus minoris, C. erythraeus ssp. (personal communication, Traub).

3. Enschoingastia (Laurentella) daria Traub & Audy

Enschoingastia daria Traub & Audy 1954:81(d); IMR 1952:93(1) (no. 46).

Records.—BORNEO (Mt. Kinabalu): Tree-shrews, Tupaioides montana baluensis, T.m. minor; dwarf ground-squirrel, Nannosciurus whiteheadi, bird (chick of an unidentified ground-bird).

* Also on Rattus alichioli in Pahang (Brinchang Hill, Cameron Highlands), 19.vi.1948 (Traub, personal communication).

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4. *Euschongastia (Laurentella) indicella* Traub & Audy

*Euschongastia indicella* Traub & Audy 1954:77(d); IMR 1953:93.


5. *Euschongastia (Laurentella) kitajinai* Fukuzumi & Obata

*Euschongastia kitajinai* Fukuzumi & Obata 1953:15(d); Sasa & Jameson 1954:261(d).

*Records.* JAPAN. *Rattus rattus* ssp. from Miyake Island.

*Remarks.* This species is very close to *E. indica* and may prove to be a geographical subspecies.

6. *Euschongastia (Laurentella) loria* (Gunther)

*Neuschongastia loriae* Gunther, 1938:204(m); Takekawa 1935, 1939 [nom. nud.].

*Neuschongastia loria* Gunther, 1939-281(d); Womersley 1939; Gunther, 1940, 1942; Radford 1942; Womersley & Henslip, 1953; Taylor & Murphy, 1946; Gunther 1952:301.

*Euschongastia loria*, Wharton & Fuller 1952:78(1); Radford 1954:265(1).


7. *Euschongastia (Laurentella) ocellifera* Traub & Audy

*Euschongastia ocellifera* Traub & Audy 1954:79(d); IMR 1952:93 (no. 49).


8. *Euschongastia (Laurentella) rattus* (Womersley & Henslip)

*Neuschongastia rattus* Womersley & Henslip, 1943:118(d); Taylor & Murray, 1946; Mohr 1947(c); Wharton & Fuller, 1952:77(b); Gunther, 1952:332(1); Radford, 1954:266(1).

*Schongastia (Aecoschongastia) rattus*, Womersley, 1952:207(d).

*Euschongastia indica*, Wharton & Fuller, 1952:77(b).


*Records.* AUSTRALIA (QUEENSLAND): *R. fuscipes assimilis* (*R. assimilis*) from Inbil and Brisbane. NEW GUINEA (?): *R. ringens* from near Sunsapor—see below.

*Remarks.* The existing descriptions are inadequate and existing drawings show some discrepancies, so that the exact status of this form is difficult to decide. A specimen kindly lent to the writer by Womersley (labelled: Paratype Schon. (Ascoseh.) ratus W & H on *R. assimilis*, Brisbane, Q. 5.4.39. W.G.H.), shows that the exceptional sexual depth (AP 42μ) which has been recorded may be an error due largely to fracture of the scutum, visible under phase contrast in the paratype examined; this may also explain discrepancies between the various published drawings of the scutum. Fig. 1 shows a normal scutum (Dermrow, see below). It is noteworthy that both *indica* and *rattus* were recorded from a collection made near Sunsapor by Mohr (1947). Identi- fications were apparently made or confirmed by Womersley. *E. rattus* was recorded as from 2 per cent of *R. ringens*, 5 per cent of *R. exulans* and from only one specimen *R.r. mindanensis*. This collection is not referred to by Womersley in his monograph (1952). These identifications require confirmation. There appear to be sufficient morphological grounds for distinguishing this form from *indica*, although further studies of material from Queensland may suggest it is, for example, an Australian or Australasian subspecies now overlapping with introduced *indica*.
Since this paper was drafted, Mr. R. Domrow of The Queensland Institute of Medical Research has kindly sent a description of a single specimen of E. (L.) rathus in his collection, taken from the type host, Rattus assimilis, Mt. Glorious, 6.viii.1951 (E. H. Derrick coll.) and identified by Womersley. Mr. Domrow has kindly allowed his comments to be quoted: the scutum is not fractured and the standard measurements are: AW 38.6; PW 52.6; SB 19.3; ASB 19.2; PSB 20.3; SD 35.3; AP 28.1; AM 28.4; AL 17.6; PL 45.6; SLE 31.6. Anterior scutal margin concave with slight convexity near AM base; Al. shoulders’ normal; posterior margin gently convex. The scutal setae are very fine, especially sparsely. Palpal formula N.N.N.N., claw slender (157.5) and longer than palpal tibia. DS fine and whiplike, resembling scutal setae, without distinct barbules (those of indica are more robust). VS small and much more numerous than in atydi or loria. Mr. Domrow considers that rathus is distinct from indica and most closely resembles loria, differing in various features such as the stumpy palpal claw and few VS in the latter.


*Euschöngastia* *roluis* Traub & Audy 1954:79(d); IMR 1952:93 (no. 48).

**Records.**—BORNEO (Mt. Kinabalu): Tree-mouse, *Chiroglossus legatus* (with *E. (L.) indica*).

10. *Euschöngastia* (*Laurentella*) *soekaboemiensis* (Takekawa)

*Pseudöschöngastia* *soekaboemiensis* Takekawa, 1954(d).


*Schöngastia* (*Neuschöngastia*) *soekaboemiensi*. Womersley, 1952:212(d).

*Euschöngastia* *soekaboemiensis*. Wharton & Fuller, 1952:83(1); Audy, 1954:154; Radford, 1954:286(1).

**Records.**—JAVA: *R. diardii*, *R. johorensis*, (*R. roquei*). SOUTH BURMA: Bandicota *bengalensis* (*Neokia bengalensis*); *Rattus* *r. khyniis* (*Rattus ratus norvegicus*, *R. r. khyniis*).

**Remarks.**—A species from South Burma (and fairly common there) was identified by Womersley with Takekawa's species (which was adequately described in Japanese but of which no material has been seen). As Womersley describes (pp. 209–211), the Burmese series can be distinguished satisfactorily from *E. indica*. The fact that *E. soekaboemiensis* has not yet been found in extensive collections in Malaya but appears to occur both north (Burma) and south (Java) of it is not exceptional because there is a faunal and floral barrier running across the extreme north of Malaya through Langkawi island and Kedah, and a number of insects, reptiles, amphibians, and mammals have been recorded north and south of Malaya but not in the body of the peninsula (see Zieuner 1941; Reid, 1950; Harrison, 1956). The assumption is that *E. soekaboemiensis* is to be added to the list of arthropods (butterflies and mosquitoes) showing a latitudinal break in distribution across the body of Malaya.

Womersley (p. 213) appears to identify *soekaboemiensis* with *cokkingsi* by inference, but *cokkingsi* is a synonym of *indica*, and the confusion was due to misidentification in the field. Fuller (1952:188) has clearly identified *cokkingsi* with *indica*, so also has Womersley (1952:208). It is worth noting that the Arakan Yoma mountain range and the Chindwin river are effective zoogeographical barriers well known to mammalogists and ornithologists. The Imphal plain, type locality of *cokkingsi* (syn.), is in

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the intervening mountain mass, and although it could have species of trombiculids introduced from either side, its general faunal affinities are on the Indian and not the Burmese side.

Womersley's data for the South Burma material are partly corrected on his p. 2b: E. sookaboemianus was found to be fairly common on urban rats, Bandicota bengalensis and Rattus r. hyensis, in and on the outskirts of 9 villages and towns visited by me. It appeared to be filling the same niche in company with indica.

B. Euschongastia debilis species-group

11. Euschongastia (Laurentella) debilis (Gater)

Euschongastia debilis Gater, 1932:166(d); Radford, 1952; Womersley & Headly, 1943; Takeda, 1945; Taylor & Murray, 1946; Thor & Willmann, 1947; Fuller, 1948.

Euschongastia debilis Fuller, 1948:106(d); Wharton & Fuller, 1952:75(1); Audy, 1954:114(1); Radford, 1954:264(1).


Previous and New Records.—MALAYA: Originally from a tree-rat, Rattus t. moriventer cremoriventer. New records, showing the numbers of debilis obtained from forest in Selangor as follows: 1 on Rattus amandei, 29.xi.1949; 3 on R. mullen, 3.xii.1950; 1 on R. sabanus, 25.xi.1952; 1 on R. juboina, 1.xii.1948; 1 on R. whiteheadi, 10.xii.1950; 1, 3, and 3 from the shrew Crocidura malayana on 1.xi.1951, 21.1.1954; and 7 from a water-shrew, 10.viii.1951. Most of these hosts are ground-animals and infestations are obviously casual, except possibly for the shrews. The sensillae are clavate.

12. Euschongastia (Laurentella) labuanensis (Womersley)


Record.—NORTH BORNEO, Labuan (island off west coast): A rat ("a marsupial rat" in original, corrected in corrigenda; Rattus sp., erroneously by Radford).

Remarks.—Womersley's figures 53H and 53J are at variance with the text. Two species very close to this have been found in North Borneo by a joint expedition with the U.S. Army Unit—unfortunately only one specimen of each was obtained. Both have barbed or branched galeal setae. The sensillae are clavate.

The Species Groups

Three groups of species may be easily recognized. The debilis-group is included in this subgenus tentatively although no nymphs are available for study. The third group comprises species which are about to be described in collaboration with Traub. As discussed below in the section on affinities, E. oculieola (Wom.) may represent a fourth group in Laurentella. Finally, a tendency towards some widening of the scutum, together with a greater separation of the SBs, may be discerned, so that one should envisage the possibility of adding a group to accommodate such species with trapezoidal or roughly rectangular rather than subquadrate scuta. The groups are distinguished as follows on larval characters, but at any moment a species may be found which would require this simple diagnosis to be modified:

1. AM seta anterior to line of ALs, with AL shoulders to scutum; posterior scutal margin convex, though perhaps slightly; galeal seta naked; palpal claws with 2 or 3 prongs; 3 genalae 1

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AM sea level with or posterior to AL; setae without AL setae. Tibia posterior 3-pronged; 2 setae each, 3 inv. 2. Tibia and tarsus of leg III normal; species either ectoparasitic or endoparasitic (intransal).  

**debilis-group**

1. Tibia and tarsus of leg III swollen (fig. 1), with an exaggerated distal tarsal segment; endoparasitic. 

**TAA-group**

The following species, including those undescribed forms which have been sufficiently studied, are included in these groups, while an opportunity is taken to summarize distribution and add minor notes not available elsewhere in this paper. N.A signify that nymphs, adults have been reared (but, except for indica and induta, not yet described). Several additional species from Borneo and Malaya are being studied.

### A. indica-group (15 species)

*E. (L.) audyi*, N. Common, arboreal animals, Malaya and Borneo.  
*E. (L.) claria*, N. North Borneo, not uncommon. Once on a bird.  
*E. (L.) indica*, N. Very common and widespread, especially on house-rats and semi-arboreal animals in forest fringe and plantations, Oriental and Australasian regions. Stragglers on a wide range of hosts.  
*E. (L.) indicella*, N. North Borneo.  
*E. (L.) kitajima*, Island off Japan.  
*E. (L.) lorius*, A bird, New Guinea.  
*E. (L.) ocellifera*, North Borneo.  
*E. (L.) ruttu*, Australasia.  
*E. (L.) rohinis*, N. North Borneo.  
*E. (L.) s.oekaboensensis*, Commensal (domestic and field) rats, South Burma and Java.  
*E. (L.) "LUM" Vercammen-Grandjean, Mammal, Uganda. This species is typical except for ceca III which is 3-4 setose. It is the only representative of this subgenus out of nearly 200 African trombiculid species.  
*E. (L.) "CAN"*, N. 
*E. (L.) "CTEN"*, 
*E. (L.) "LAU"* (38520). Intransal, fairly common on *R. crevaci* in Malaya; once on *Callosciurus nigrovittatus*, Malaya.  
*E. (L.) "NEW"*, Intransal, rats in North Borneo (Traub coll.).

### B. debilis-group (4 species)

*E. (L.) debilis*, Rare, Malaya; particularly on shrews.  
*E. (L.) labuenensis*, Rat, Labuan off Borneo coast.  
*E. (L.) "ALT-B"* (40592). One specimen, *Rattus alticola*, Beaufort, near coast opposite Labuan, North Borneo.  
C. TAA-group (3 species)

E. (L.) "TAA" (38669). N. Intranasal, occasionally on R. rajah surifer, Malaya.

E. (L.) "TBB" (38601). N. Intranasal, in large numbers (about 30 per rat) on R. rajah surifer; also on R. rajah pelax, and occasionally on R. cre- miventer, R. whiteheadi, R. sumatranus, and R. bowersi, Malaya.

E. (L.) "TMM" (40008). N. Intranasal, fairly common on rats, Mt. Trus Madi, North Borneo.

Biology

Location on host.—Philip & Woodward (1949) noted that indica was the only urban trombiculid encountered by them, and that at least in Manila the larvae attacked not only in the usual hollows in the outer conchae of the ears (a site of election for many species of trombiculids) but "along the whole external auditory canal". We have observed the same thing in Malaya, and also in Manipur, the larvae sometimes lying deep in the canal in a mucoid secretion. This habit is doubtless related to the development of intranasal endoparasitism, some species of this subgenus being found deep in the intranasal cavities of rodents, especially Rattus rajas (IMR 1934:57, 83; Audy & Verbaanen-Grandjean, 1955). At least one of these intranasal species appears to be common in North Borneo as well as in Malaya. There is a tendency for these intranasal forms to become less heavily chitinized and with less setal ornamentation generally, to have modified palpal claws and sometimes chelicerae, and also to develop a peculiar modification of the tarsus and tibia of leg III (Fig. 1). Species with the last-named character are here placed in a group (TAA) by themselves. Nymphs of several intranasal species from Malaya and Borneo have been reared; they show no particular characters distinguishing them from ectoparasitic forms. Serial sections of the nasal capsule of R. rajas, sometimes with as many as 15-20 larvae (including sp. "TBB") in one plane, show several larvae attached by chelicerae but no signs of the sucking tubes which trombiculid larvae characteristically develop. The larvae, most of which always appear to be engorged, move about freely in the intranasal mucus.

Feeding Times of Larvae.—Harrison (1954:181) found that the feeding-times of larvae identified as E. indica appeared to be bimodal, one group with a short feeding time ranging around 9 days, and another with an undetermined mean ranging above 12 days and possibly up to some weeks. He stated that "such an inconsistency may indicate different biological races, or a feeding time which varies with host behaviour..." The possible relationship of this finding with the red and white forms of indica (see h below) is being investigated. Wharton described larvae of indica on Guam as being "orange white to cream" and he reported feeding times of 10 to 32 days. Other miscellaneous references to feeding times of trombiculids are in Audy (see Trop. Bk. Bull., 1948, 45, 66) and Wharton & Fuller 1952:18.

Habitat of Nymphs and Adults.—The free-living post-larval stages of E. indica have been recovered from coconut-palm tops in Addu Atoll, Maldiveis (Radford, 1946), where rats apparently nested, and particularly from nests of R. mindanensis in the bases of epiphytes in Guam by Wharton (1946), who stated that the free-living stages of indica were largely "restricted to runways, nests, and hiding places of R. mindanensis that were protected by some sort of cover". Nests in or near the ground were much less freely infested. Gispen (1950a) attempted to pick up chiggers by exposing rats as bait.
and while he failed to recover *indica* from rank grassy areas (Isang), he recovered 3 larvae from rats exposed near rat-holes. These findings help us to interpret the host infestation data given below.

**Host Relationships.**—All the species of *Laurentella* appear to belong essentially to forest rodents, and to some extent insectivores, with the exception of *E. indica* which occurs in largest numbers in plantations and towns. The following hosts are principally involved—information about their habitat and behaviour may be found in Harrison & Lim (1950), Harrison (1954, 1957), and Harrison & Audy (1954).

i. **Commensal Animals.** Commensal animals are here taken to include all those which are encouraged by man-made conditions, either house-building or interference with natural vegetation to produce seral patches, gardens, and plantations. Domestic animals are a special group. Commensals generally include introduced species. In the case of *E. indica*, only commensal rats appear to be infested significantly.

(a) *Rattus exulans* (— *R. concolor*), and *Mus musculus* in Malaya. Both of these haunt houses, but the former is more frequent in scrub and grassland. They are notable for being generally very lightly infested by trombiculids. *R. exulans* in the field in Selangor carries equal numbers, about 1 per rat, of *E. indica* and *Trombicula deltiens*. In the town, it is negligibly infested by *indica*.

(b) *Rattus rattus diardii* and *Rattus norvegicus*, house rats. The number of *indica* found on house-rats in towns in Malaya, about 10–20 per rat, compares with the number given (16 per rat) by Gispen (1950a) for house rats in Batavia. He states that sewer-rats (*R. norvegicus*) appeared to be attacked more frequently than house-rats (*R.r. diardii*) in Batavia, 80 per cent and 31 per cent respectively being infested. Twenty-three *R. norvegicus* caught in Tjikini market were all infested, with about 20 *indica* per rat. In Guam, Wharton (1946) reported *indica* absent from 88 *Mus musculus* and 60 *R. exulans* from villages and open grassy areas and gardens nearby—the latter were apparently not infesting the houses significantly.

It is now well recognized that *E. indica* is a very widespread urban trombiculid, often the sole species on house-rats, over the whole of its range. Other species which also occur locally on urban rats are: *Trombicula mundi* Gater, in small numbers on *R.r. diardii* in Kuala Lumpur; *E. (Laurentella) soekabernierensis* on *R.r. khyensis* in Rangoon and other towns of South Burma; *Gabrielopsis* (Schinogastella) *ligula* (Rad.), in towns of South Burma and many parts of India (see Traub & Evans, 1954:102).

(c) *Rattus rattus argentiventer*, field-rat in Malaya. This rat is restricted to open grassy areas in Malaya and is the principal host of *T. okamushi* and *T. deltiens*, the vectors of scrub typhus. It is only occasionally infested by *indica* (average 1 per rat). Philip et al. (1949) described an experiment in a young rubber plantation with undergrowth, where *E. indica* was scanty on *R.r. argentiventer* except in one subarea (ID) described as being higher and drier than the others. This particular area included the remains of an old food-store destroyed by the Japanese and since overgrown, so that much of the *indica* may have been a relic from house-rats formerly infesting the store.

(d) *Rattus rattus jaborensis*, Wood Rat, in Malaya (see *i* below). This is a semi-arboreal rat also coming down to the ground, belonging particularly to the forest fringe where the canopy descends to shrub level (Harrison, 1957). It is a major pest of plantations of rubber and oil-palms. Specimens from an oil-palm estate near Sungai Buloh carry about 37 *indica* per rat, and occasionally a few specimens of *audyi*.

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(e) *Rattus* sp. in Addu Atoll, Maldives. This rat was identified in the field as *R. norvegicus* by Radford (1945) but Gardiner (1906:1049) records the rat on Addu as *R.r. alexandrina*. It was ubiquitous over the atoll, and was frequently seen in coconut palms and running along telephone wires strung between trees, so that it was behaving like a *Rattus rattus*. These rats, taken from all parts of the island, had about 15 *indica* per rat (Kaira and Radford, personal communications, and Kaira, 1947). Adults of *E. indica* were discovered in the dead flowers and leaf debris in the tops of the coconut palms.

(f) *Rattus rattus mindanensis* (see also g below). This is the town rat of Manila, described as freely infested by *indica* by Philip & Woodward. It has been introduced to Guam where Whiton (1946) describes it as abundant, especially in rain-forests, plantations and gardens, and in villages where the natives complained of these rats in their thatched roofs. The incidence of *indica* was however low among the village rats (3 infested out of 164 from Agat), which demands explanation. Although this rat occurred over most of the island, infestation by *indica* was local, being mostly in the western part of a rain-forest which encircled a plateau in the north part of the island, and also in various coconut groves. In the latter, the rat was presumably behaving like the rats on Addu and in the oil-palm estate in Malaya. *E. indica* was not found in grassy areas on the plateau, which had followed cultivation and deterioration of the soil.

ii. Forest Animals. (g) *Rattus rattus mindanaeensis* in forest on Guam. Whiton found that rats collected in rain-forest at Ritidian and Pataw Points were not infested although the highest infestation occurred at Oa Point in similar surroundings. This remains unexplained. At Oa Point the rats were living and nesting particularly in the soil-like masses at the bases of epiphytic ferns, from which adults, nymphs, and larvae of *indica* were repeatedly recovered. Collections of fruits of *Ochrosia* were useful indicators of the presence of hiding places and burrow-entrances of the rats. Nests in or near the ground, except for two nests under the protection of logs, were generally uninsected; while nests in trees, which were apparently better drained, were freely infested.

(h) *Callosciurus tenus* in Malaya. This small squirrel is essentially a forest tree-squirrel which may extend across the forest edge into plantations, etc. It is diurnal while the rats are essentially nocturnal. It apparently builds nests of twigs (at canopy levels?), which by local accounts are particularly in axils and tree-holes; and the range of individuals, as with squirrels generally, is likely to be significantly greater than the corresponding range of rats (Harrison, personal communication). Sixty-one *C. tenus* from our general collections had the following average numbers of trombiculids per individual: 11 *E. "indica"*, 14 *E. audyi* with a new species *E. (L.) "CTEN"*, 2 *E. (Otaichiella) ootemans*, 3 *Trombicula spica*, and occasionally a few other species. No other arboreal animal has so many *indica*-like trombiculids on it, but the identification of these is provisional because the 11 "indica" per squirrel include not only some whitish larvae indistinguishable from *indica* but also red larvae, which are morphologically so close to *indica* as to be confused with it. Further discussion is therefore profitless without more detailed taxonomic studies.

(i) *Rattus rattus jaloremensis* in Malaya (see d above) from the forest fringe carries both white larvae and red larvae, the latter apparently *indica* and apparently the same as the red larvae on *C. tenus*. Possible morphological differences are being investigated but there may be two biologically distinct forms present.

(j) Tree-swings are as much terrestrial as arboreal. They have about 2 *indica* and 4 *audyi* per animal in Selangor.
(k) Chiropodomys. These are very small rats which in Malaya nest in the inter-nodes of bamboo after making a small entrance hole and biting through some of the partitions. Specimens of a relatively large species were found on Mt. Kinabalu in Borneo by one of the joint U.S. expeditions to be not only in bamboo but also in tree-holes in dead palms. Seventy-six specimens of C. girouard from Malaya were found to be uninfested, but C. legerus on Kinabalu is the host of E. (L.) indicella, E. (L.) rotundus, and E. (L.) ocelliferus.

(l) Rattus canus in Malaya is a strictly arboreal rat. One hundred and twelve specimens from our general collection had an average per rat of 1 E. indica, 3 E. audyi, several of a new species E. (L.) "CAN", and 19 Ascoschongestia malayanensis, all of which we consider to be related; and also 1 T. spicau and 11 E. (W.) audemansi.

(m) Rattus creativiventer, the Pencil-tailed Tree-rat, in Malaya. This is a strictly arboreal forest rat like R. canus but differs sharply from it, and at the same time resembles R. rajah on the ground, by being infested rarely by external chiggers but moderately by intranasal ones (species "LAU" dominant). Of 172 R. creativiventer examined (1949-55), only 5 were infested with ectoparasitic chiggers: 6 Gahriilepsia (G) fleischeri, 5 Gahriilepsia (Walchia) pingue, 26 E. (Walchiella) audemansi, 8 E. (L.) indica, 1 Trombicula spicua, 1 T. (Leptotrombidium) sp. nr. bodensin—a.d. only 0.23 chiggers per rat. An exceptionally low degree of infestation. Of these rats, 15 (1954-55) were also examined for intranasal species, and these had: E. (L.) "LAU", 45 on 4; E. (L.) TAA-group, 10 on 2—a.d. about 3-4 intranasal chiggers per rat.

(n) Rattus rajah (Spiny Rats) in Malaya. The two colour-forms R. rajah surifer and R. rajah pellicae are doubtfully separable according to Harrison (1957). These rats live on the forest floor and make burrows in the ground, with which habit we associate an unusually heavy infestation by nest-parasites such as Paramospid mites and fleas. R. rajah is notable for being unusually lightly infested by external trombiculids (average 3-4 chiggers per rat, mostly G. (Walchia) pingue), but exceptionally heavily infested by intranasal chiggers (average of 36 intranasal chiggers per rat); the results of examining 15 R. rajah surifer being as follows:—Dolostis (VR-group), 341 on 61; E. (Laurentella, TAA-group), 641 on 30; G. (Walchia) pingue, in ears, 495 on 29. A most interesting fact is that the Gambian Rat, Cricetomys, is, according to Vercken-Grandjean, similarly infested by intranasal rather than external trombiculids (Audy & Verc., 1955, in which the figure of 70 is an approximation of the number of intranasal chiggers per infected R. rajah, not per rat). It will be noted that intranasal Dolostis is particularly associated with ground-rats, while intranasal Laurentella is associated more with tree-rats and squirrels.

Affinities

It will be seen from the above data that this subgenus forms a fairly consistent group biologically. There is some evidence that these mites generally infest nests or their immediate environment, in contrast to such species as T. deliensis and T. akamushi which infest other parts of the hosts' ranges. Nest-infestation by the tree-living stages is a specialized adaptation, and though it is not so intimate as spending the whole life-cycle on the host, it is sufficiently close for a certain degree of host-specificity to develop. There is some evidence that this might be happening in this subgenus, although extensive collections would be necessary to prove it.

An unusual example of host-specificity is that of Ascoschongestia malayanensis, restricted to R. canus and probably a nest-infesting chigger. Larvae are found deep within the auditory canal of the rat in glutinous mucoid secretion. The recession of the scutum
so as to leave the PL setae isolated is a character which has developed in various unrelated groups (e.g. intranasal Dolosisia, Audy 1954:157). It is reasonable to suppose that A. malayensis has been derived from a Laurentella stem—it would certainly be included in Laurentella on larval characters if the PL setae were placed on the scutum.

The species which have been placed in the genus Ascoschönagastia, of which malayensis is the type, themselves show the same range of variation which is to be found between the indica-group and the debilis-group. The writer is at present of the opinion that Laurentella and Ascoschönagastia may prove to be congeneric (cf Dolosisia and the VN-group, Audy 1954:157); but neither promotion of Laurentella to a genus nor reduction of Ascoschönagastia to a subgenus of Euschönagastia would be helpful steps to take at this stage.

The debilis-group, here tentatively included in Laurentella, has all the general characters of the indica-group except that the galeal seta is usually barbed, and the AM seta is placed more posteriorly so that the AL “shoulders” of the scutum are absent. Nymphs are unknown, all the three species in this group being rare. There is a general resemblance between larvae of the debilis-group and larvae of the genus Pseudoschönagastia, in which there are two special development, viz. the retraction of scutum away from the PL setae, and the fusion of the femor of legs II and III so that the legs are segmented 7.6.6 instead of the usual 7.7.7. Both these are recurrent polyphyletic characters which have been discussed by Audy (1954:125, 154).

The 7.6.6-segmentation of legs II and III, formerly considered characteristic of the Gahlriepinae (— Walchiinae), can no longer be regarded as a subfamilial character. Both types of segmentation have been found in extremely closely related members of (a) the Trombicula panieri group (Audy 1954:147) in Africa and Malaya, (b) the 7.7.7 E. leucospic group which should probably be included with the 7.6.6 ctenocephali-group in Walchiella, and (c) Schouwdenichia, only the restricted fuller-group of which has 7.6.6 legs (Vercken, 1955; Vercken & Audy, 1956). The fusion of basifemur and telofemur appears to be related in these miles to the length of the leg-segments, fusion tendency to occur among the short-segmented species, and Vercken (personal communication) has related this character to a ratio of segmental length to width.

A further relationship is with Euschönagastia (oculicola-group) oculicola (Womersley), comb. nov. [= Schönagastia (Schönagastia) oculicola Womersley, 1952: 167(d), 383(dN); ?Dolosisia (oculicola-group) oculicola, Audy, 1954:159(1), tentative allocation; Schönagastia oculicola, Radford 1954:267(1)]. In a discussion of relationships, Audy noted that this species was peculiar in both larva and nymph and that on the whole it shared most characters with Dolosisia, including the intranasal VN-group (oculicola itself is incidentally from the conjunctival sac of rats). He therefore considered it to represent a distinct species-group (at present monotypic), of uncertain status; and he tentatively proposed to place it in Dolosisia, sensu lato. In this, he was misled by a confusing number of new species showing larval convergence—and in the case of oculicola, also some nymphal resemblance to nymphs of Dolosisia. These converging larval forms have since been satisfactorily sorted out into three groups: (i) certain forms, mostly intranasal, of Laurentella, (ii) E. oculicola itself, and (iii) certain forms, especially the intranasal ones, of Schouwdenichia (see Audy, 1956b). The chief characters leading to confusion among these larvae are (a) general reduction of scutum and gnathosome, (b) intranasal or conjunctival habitat (i.e., on mucous membranes or in relation to mucocutaneous junctions), (c) strong curved palp claws, (d) modification of chelicers, by reduction and usually by the appearance of a medial or dorsomedial tooth, which may be fairly large as in Dolosisia itself, (e) frequently short stumpy legs.
and (f) a constriction of the body of engorged larvae. It is now possible to say that *octicola* is not a *Dolobisia* but is very close to *Laurentella*, in which it will doubtless be included shortly although it is premature to make such a change until the whole array of available species, larvae and nymphs, have been described. The larva of *E. octicola* has short strongly curved palpal claws, a small chelicera with a prominent cersomedial tooth (there are some inaccuracies in the original description and illustrations which are corrected by Womersley & Audy, 1957), while tibia III is present and there are 3 genuine I; the strong development of the AM seta of *octicola* is reminiscent of that of *debilis*. Nevertheless, this species, and also *Schoutedenichia*, forms a link between *Euschöngastia* and *Dolobisia*, while *Dolobisia*, *Guntherana*, and particularly *Schoutedenichia*, form a link between the Trombiculinae and Gahrieulinae, strong enough to break down most of the distinctions between the two subfamilies.

In the case of *Dolobisia* and endoparasitic forms of *Schoutedenichia*, various obvious similarities with larvae of *Laurentella* are almost certainly due to convergence rather than direct relationship, for the larvae of the former are all distinguished by the regular absence of tibia III and presence of only 2 genuae I, while the nymphs are distinguished by a generally *Gahrieulia*-like facies, the nymphs of the latter being typically *Euschöngastia*-like.

On the other hand, *Laurentella* closely resembles the *Trombicula pontieri* group of Audy 1954b:147 in both larval and postlarval characters. The chief morphological difference appears to be in the sensillae of the larvae, which are expanded in *Laurentella* and simple in the *pontieri*-group. There appears to be a close phylogenetic relationship between the two groups. Although there is a natural tendency to group together chiggers with expanded sensillae and those with unexpanded sensillae, there is little doubt that expanded sensillae have arisen independently in unrelated groups.

It appears to the writer that *Laurentella*, *Aecosphengastia*, the *octicola*-group, and *Pseudoschöngastia* are parts of one complex which should be studied as a whole. There is a general similarity between nymphs of these groups and the writer is at present unable to distinguish nymphs of *Laurentella* from those of *Aecosphengastia* and *Pseudoeschöngastia* except at the species level.

**Medical Importance**

Traub et al. (1950) recovered the infective agent of scrub typhus, *Rickettsia tsutsugamushi* (= *R. orientalis*) from each of two pools of 30 and 50 larvae of *E. audyi* taken from two tree-squirrels, *Callosciurus nigrovittatus*, from forest near Kuala Lumpur. Their paper includes valuable discussions on the possible role of such vectors in the transmission of enzootic scrub typhus ("jungle tsutsugamushi", also discussed by Audy & Harrison 1951:389).

In the same year, Gispen (1950b) reported the recovery of the infective agent of "endemic" or "murine" flea-borne typhus, *Rickettsia mooseri* (= *R. typhi*). Five strains of this organism were recovered from 82 individual pools of 2,598 *E. indica* from house-rats in Batavia. Infections were recovered from mites taken from both *R. diardi* and *R. norvegicus*, while four of the positive pools were taken from rats in which no trace of infection was found (the fifth being from a rat shown to be itself infected). Gispen concludes from this that the infection must have been transmitted to the larvae through the eggs, a mode of transmission known to occur with rickettsiae in mites andticks. If the rickettsiae penetrate the gut wall and reach organs such as the ovary, it is probable that they would also be able to reach the salivary glands at least occasionally.
in which case the mites should be capable of some degree of transmission. In investigations of the sort described by Gispen, attempts should also be made to recover rickettsiae from the epithelium of the areas in the ears on which the mites regularly feed. Since *E. indica* is a very common and very widespread parasite of house-rats in the far east, its potentialities as a vector of any pathogen should be investigated further.

**Summary**

1. A new subgenus, *Laurentiella*, is raised to accommodate those trombiculid mites hitherto contained in the 'indicoid-group' of *Euchoengastia*, sensu lato, together with a *dechile* group and a third group comprising certain undescribed endoparasitic species which have a modification of leg III. Over 22 species, including one from Africa, are ascribed to this subgenus: of these, 12 have been described and are here listed together with synonyms, references, new records, and some discussion on taxonomy and distribution.

2. The type species, *Euchoengastia (Laurentiella) indica*, is extremely widespread and occurs particularly on domestic rats in most urban areas from India to New Guinea and the Philippines. Another species, *E. (L.) audyi* is a dominant chigger on tree-living mammals from Malaya and Borneo.

Rickettsiae responsible for non-epidemic forms of typhus infection have been recorded from both these common species, which may therefore be of importance in transmitting infection among their animal hosts.

3. It is considered that *Laurentiella*, *Euchoengastia oculeola*, and the genera *Ascoschoengastia* and *Pseudoschoengastia* form a complex which should be studied as a whole. It is also considered that *Laurentiella* has a common origin with the *Trombicula panier* group.

4. Observations are made on the biological and zoogeographical interest of members of this genus, and their host-relationships are discussed. There appears to be some general association with nests of hosts, leading to a degree of host-specificity which is not common among trombiculids. One species, *E. (L.) soekaboeniensis*, shows a break in distribution across the body of Malaya, in common with a number of animals and arthropods. At least 5 species awaiting description have been found to be endoparasitic in the nasal canines of rats in Malaya and Borneo.

**References**

*Those marked with an asterisk have not been consulted by the writer.


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This number of the Bulletin of the Raffles Museum (No. 28) follows No. 27 and is the second number to be printed at a new and larger page size. No. 26 is in the press and will appear in the former (smaller) page size.

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