

Discovery of a Eusocial Halictine Bee, *Lasioglossum (Evyllaesus) subtropicum* sp. nov. from Iriomote Is., Southernmost Japan, with a Morphometric Comparison of Castes in some Social Halictines (Hymenoptera, Halictidae)¹⁾

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Abstract *Lasioglossum (Evyllaesus) subtropicum* sp. nov. is a eusocial halictine bee recently discovered on Iriomote Island. It is similar to some species of the *L. (E.) fulvicorne* group s. lat., particularly to *L. sibiriacum* (Blüthgen) and *L. baleicum* (Cockerell), but is peculiar by the propodeal dorsum not distinctly carinate at the end. Comparison with some other social halictines shows its conspicuous size difference between queen and worker than in these species. Bionomics of this species will be described in a separate paper.

Key words: Morphometry; social bees; *Lasioglossum subtropicum* sp. nov.; Iriomote Is.

Introduction

Iriomote Is. (24°15-25'N, 123°40-55'E) forms the southernmost boundary of Japan. It is located about 100 km south of northernmost Taiwan and 200 km east of its nearest coast. With an area of 284 km², it is the 5th largest island of the Nansei Shotô (southwestern archipelago) of Japan. The climate is subtropical. Kira's effective accumulative temperature for the plant growth, $\Sigma(t_i-5)^3$, is 220.3°C, just within the subtropical thermal zone (180-240°C) defined by him (1945). Unlike many other islands of Nansei Shotô, natural vegetations are still relatively reserved and support the life of various animals which has not been yet well surveyed, as shown by the postwar discovery of an endemic wild cat in 1965, *Felis* (or *Prionailurus) iriomotensis* (Imaizumi 1967), first described as representing a monobasic genus *Mayailurus*.

Nest aggregations of *L. subtropicum* were discovered on a gently sloping hill. Nest sites and nest architecture will be detailed in a coming paper.

Some morphometric abbreviations (explanations in Sakagami, 1989, 1991, in press Sakagami and Tadauchi, in press): L, W=maximum length and width; D=minimum distance; BL=body L; WL=wing L (including tegula); WD=wing diagonal distance; HW, HL=head W, L (excluding clypeal tooth); MsW, MtW=mesosoma, metasoma W; UOD, MOD, LOD=upper, maximum, lower interorbital D; CAL=clypealveolar L; EL=eye L; EW, GW=eye, gena W; SPL=scape L; MSL, MTL, PDL=mesoscutellum, metanotum, propodeal dorsum L; IOD, OOD, VOD=interocellar, ocellocular, verticorbital D; F_nL, W=L, W of flagellomere *n*.

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³⁾ t_i is the mean air temperature of the month *i* of which t_i is > 5°C, ignoring the months with $t_i \leq 5^\circ\text{C}$. In the present case, $t_i > 5^\circ\text{C}$ in all months.

Further, T_n , S_n =metasomal tergum n and sternum n ; PP=punctures, IS=inter-spaces between punctures; PMA=postmarginal area of metasomal tergum; Q=queen or queenlike; W=worker or workerlike.

Lasioglossum (Evylaeus) subtropicum sp. nov.

Female BL 6.7-8.2 mm (Q) or 5.3-6.7 mm (W). WL 5.8-6.2 mm (Q) or 4.5-5.2 mm (W).

Unless specified no caste-linked difference occurs in non-metric characters.

Color

Queen nearly concolorously jet black, except flagella below apically (brown to blackish brown), mandibular apex (reddish brown-tinted), pronotal lobe apically (brownish), tegula (pale brown, nearly transparent), femur-tibial junctions (brown), distitarsi (blackish brown). Tergal margin broadly semi-transparent, seen brown. Wings very slightly infuscate, veins brown.

Worker as in queen but sometimes partly paler, *e. g.*, flagella below brown to pale brown, scape frontally dark-brown, femur-tibial junctions to pale or yellowish brown, tergal margins paler.

Pilosity

Queen: Rather sparse, not much hiding surface. Whitish except tergal dark setae, but often tending pale yellow to pale yellow brown on legs and mesosomal dorsum; mostly simple to poorly plumose unless mentioned.

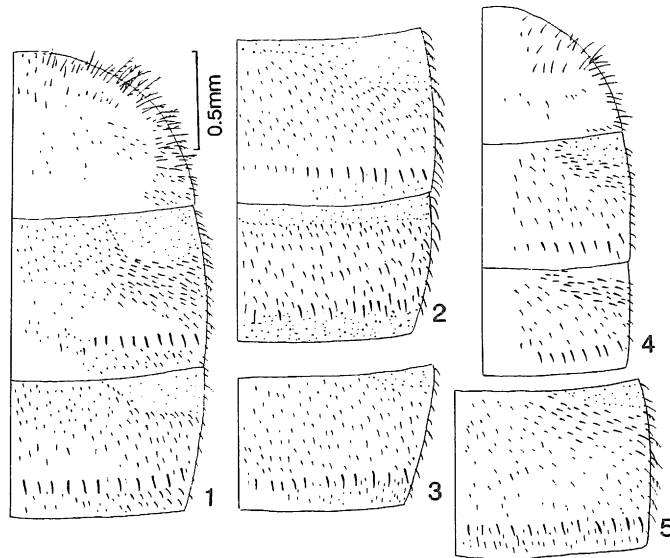
Head: Erect on vertex ($\pm 200\mu$), semierect to appressed on face and paraocular area ($150-175\mu$), the latter plumose and semi-hiding surface. Gena medially weakly tomented.

Mesosoma: Pronotum on anterior surface (except periphery) and dorsum anteriorly distinctly tomented as around pronotal lobe. Mesoscutal hairs sparse and inconspicuous, longer hairs $\pm 150\mu$, shorter ones $\pm 50\mu$. Mesoscutellar hairs similar but posteriorly longer, attaining 300μ . Metanotal tomentum confined to anterior part. Mesepisternal hairs distinctly plumose, above $125-250\mu$, below to 325μ , with sparse and short underhairs ($25-50\mu$). Propodeal scopa dense and distinctly plumose, propodeal side and shield not tomented. Tibial scopa normally dense as in most *Evylaeus*.

Metasoma (Fig. 1): T_1 , on slope medially with erect, slightly dense hairs ($125-150\mu$); laterally longer (to 375μ) and distinctly plumose, gradually shorter postward; disc with finest and very sparse hairs, seen as if glabrous, PMA with appressed hairs ($\pm 85\mu$) only on lateral corner. Basilateral patch conspicuous on T_{2-3} , hidden by T_{n-1} on $T_{4,5}$ though occasionally exposed; Hairs on posterior margins of patches directing outward (T_2) or obliquely outward (T_3). T_2 disc with fine, sparse and inconspicuous hairs, though denser than on T_1 ; boundary between disc and PMA medially not demarcated with hairs, but laterally with a row of postward directing and equidistantly spaced bristles ($85-150\mu$), longer laterad; PMA medially virtually glabrous, but later-

ally with obliquely outward directing appressed hairs, longer laterad. T_{3-4} similar to T_2 , but hairs gradually denser, longer, and differentiation between disc and PMA decreasing. Sternal scopa erect (to 625μ), hairs distinctly branched.

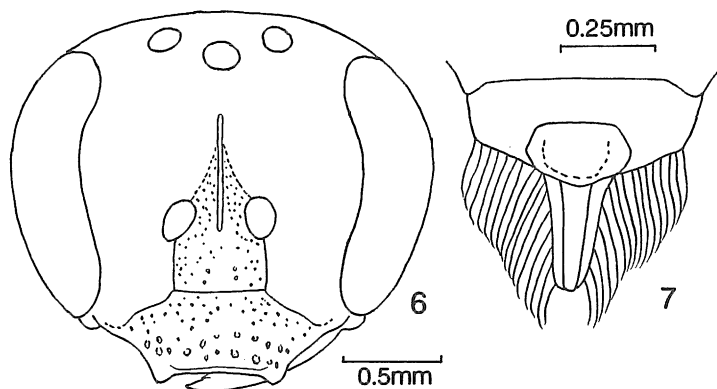
Worker: As in queen but hairs shorter, reflecting smaller body size, *e. g.*, 175μ on vertex, and mesoscutal longer and shorter hairs $\pm 125\mu$ and $25-30\mu$, respectively.



Figs. 1-5. Metasomal pilosity of *L. subtrropicum* (1: ♀, 4: ♂, T_{1-3} right half) and of allied species (all ♀, T_n right half), 2: *L. sibiriacum*, T_{2-3} , 3: *L. vulsum*, T_3 , 5: *L. boreale*, T_2 (Contour of Fig. 1 was used to draw Figs. 2, 3 and 5).

Structure (Unless mentioned no difference between Q and W)

Head: Transverse (Fig. 6), $HL/HW=0.88\pm 0.01$ (0.87-0.90, $n=10$) in Q or 0.90 ± 0.02 (0.86-0.93, $n=10$) in W. Vertex medially flat, laterally mildly outcurved;



Figs. 6-7. *L. subtrropicum*, ♀, 6: Head seen frontally, 7: Lower margin of clypeus and labrum.

lateral ocellus distant from summit shorter than own shorter axis. Occiput not carinate. Inner orbits slightly convergent below. UOD:MOD:LOD=1:1.23:1.00 (Q) or 1:1.21:1.00 (W) ($n=10$ in both). Outer orbit mildly rounded. IOD:ODD:VOD=1:0.86:0.66 (Q) and 1:0.85:0.63 (W) ($n=10$ in both).

Ocellocular area, face and paraocular area densely reticulo-punctate (PP $\phi = \pm 20 \mu$ on ocellocular area and $\pm 20-25 \mu$ on face). Frons flat, frontal carina above attaining MOD.

Supraclypeus distinctly convex, higher than clypeus, smooth and shiny; medially with sparse PP ($\phi = 25 \mu$, IS \gg P ϕ). Clypeus nearly flat, above smooth and shiny, laterally finely lineolate, with sparse PP ($20-25 \mu \phi$, some ones $\pm 10 \mu$). IS $> 1.0-2.0$ or more, below PP more reduced, rather homogeneously smooth and shiny, with some shallow and ill-defined PP, being much weaker than those in many other halictines. Clypeal tooth distinct, stronger than in many carinaless *Evylaeus*. Seen laterally gena distinctly wider than eye, particularly in Q. EW:GW=1:1.29 (Q) and 1:1.16 (W), ($n=10$ in both) with fine PP and striation.

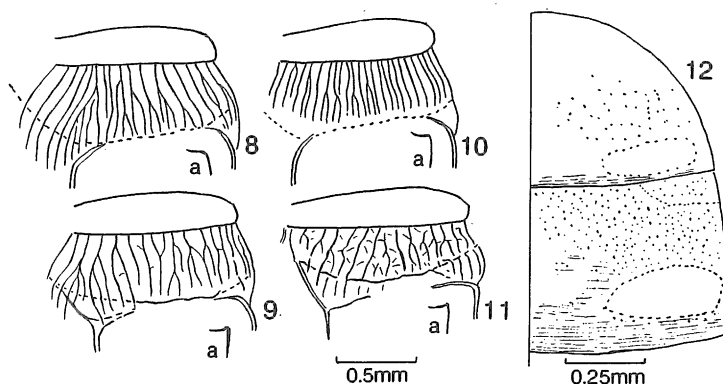
Labum (Fig. 7) as in other *Evylaeus* with tapering apical process. Mandible normally bidentate. Scape attaining or slightly exceeding upper rim of mid-ocellus (Q) or attaining middle to upper rim of mid ocellus (W).

Mesosoma: HW:MsW:MtW=1:1.06:1.13 (Q) or 1:1.04:1.12 (W, both $n=10$). Lateral angle of pronotal ridge obtuse. Mesoscutum anteriorly roundly declivous, PP medially $\pm \phi 20 \mu$, rarely to 25μ , IS finely granulo-tessellate and dull, 0.5-1.0 of P ϕ , finer and weaker (P ϕ 10-15 μ) toward anterior and posterior margins. Mesoscutellum granular, medially weakly depressed, submedian convexity centrally smooth and shiny, with sparser PP (IS \gg P ϕ). Metanotum homogeneously finely granular. Mesepisternum impunctate, coarsely granular with irregular but often transverse carinulae, MSL:MTL:PDL=1:0.63:0.78 (Q) or 1:0.63:0.75 (W, $n=10$ in both).

Propodeal dorsum (Fig. 8) mildly slanting, medially slightly depressed and apically mildly raised, with rather dense (25-30 μ distant from each other), longitudinal ridges (slightly weaker in some W), sometimes but not conspicuously branching, IS finely granular; laterally some ridges descending down granular side slope; dorsal end distinctly angulate but not transversely carinate (Fig. 8a, compare with Figs. 9 and 11a). Shield finely granular, lateral carina upward attaining dorsal end, bending there inward and weakened.

Tegula seen smooth, with finest PP anteriorly. Transverse cubital veins 2, 3 and recurrent vein 2 very weak. Number of hamuli 2-1-2 in all 10Q, 10W (and also in 10 σ^7). Basitibial plate elongate oval, encircled with distinct carina inner hind tibial spur with 2-5, mostly 3-4 slender teeth, being longer than spur's width.

Metasoma: Lateral convexities mild but recognized on T₁₋₃. T₁: Anterior slope nearly smooth and shiny (Fig. 12), in some specimens with sparse finest PP; disc with finest, sparse PP; PMA impunctate, occasionally with imperceptibly fine striation. T₂: PP on disc denser and coarser, particularly on anterior part, though still fine; disc posteriorly and PMA with distinct striation, on the former intervened with fine PP. T₃₋₄: Both discs and PMA densely striate, on disc intervened with sparse, fine PP.



Figs. 8-12. Propodeal dorsum of *L. subtropicum* (8), *L. baleicum* (9), *L. boreale* (10), *L. sibiriacum* (11), (in all ♀, "a" shows cross-section of dorsal end with distinct apical carina (9, 11) or not (8, 10); 12. Sculpture of metasomal terga 1, 2 (T_1 , T_2) of *L. subtropicum* ♀.

Male BL 6.0-7.6 mm, WL 4.6-6.0 mm ($n=10$).

Color

Black as in female. Pale parts: Apical half of pedicel below and flagella below pale to yellowish brown. Clypeus below transversely yellow (medially slightly pointed upward). Pronotal lobe lemon yellow. Femoral apex to distitarsi yellow, but tibia medially with broad pale brown stripe (fore tibia), or medially black (mid and hind tibiae), apical tarsomere slightly brown-tinted.

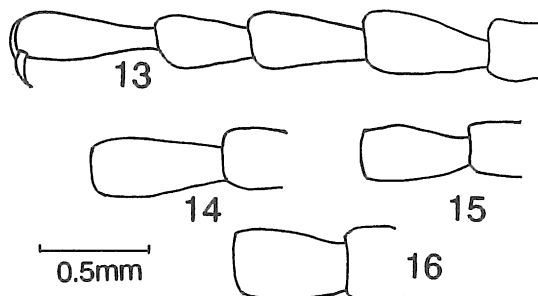
Pilosity

As in female, but 1- Paraocular and supraclypeal tomenta denser, more hiding surface. 2- Propodeal scopa less developed, propodeal side and shield distinctly tomented, though the latter lesser. 3- Tergal basilateral patches smaller, usually reduced on T_4 and invisible on T_5 . 4- Discal hairs (Fig. 4), though gradually denser on apical T_n , generally far sparser than in female, except outward- and obliquely outward- directing hairs behind basilateral patches, contrasting other sparse discal hairs. 5- Sternal hairs sparse, slightly denser apically, especially apico-laterally, without any deformity.

Structure

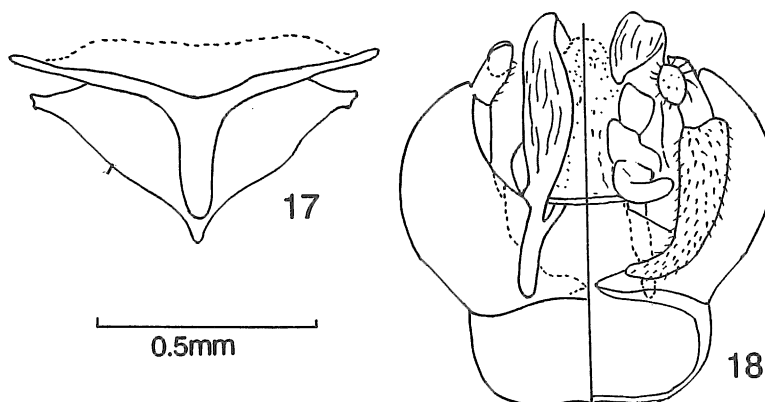
Head as in female but nearly as long as wide, $HL/HW=1.00\pm 0.01$ (0.98-1.03, $n=10$). Lateral ocellus slightly below summit. Both outer and inner orbits more convergent below. $UOD : MOD : LOD=1 : 1.17 : 0.77$, $IOD : OOD : VOD=1 : 0.65 : 0.65$. Supraclypeus less convex, granular, with $PP (\phi 20\mu) \leq IS$. Clypeus flatter, above with PP slightly denser. Gena much narrower than eye, $EW : GW = 1 : 0.66$. Antenna attaining metasoma. $F_1L : F_3L=1 : 2.66$.

Mesosoma: As in female, but $HW : MsW : MtW = 1 : 1.16 : 0.98$. Mesoscutellum medially less depressed and submedian convexities with PP denser and IS less shiny. Propodeal longitudinal ridges stouter, $MSL : MTL : PDL = 1 : 0.58 : 0.75$. As in many other halictines, transverse cubital veins 2, 3 and recurrent vein 2 stronger than in female. Basitibial plate represented by a flat elevation, covered with sparse finest setae and marginally not carinate. Inner hind tibial spur edentate. Hind distitarsus 1 basally narrowed (Fig. 13) as in *L. sibiriacum* or *L. baleicum* (Figs. 14 and 15) not wide as in *L. laticeps* (Fig. 16).



Figs. 13-16. Male hind distitarsi of *L. subtropicum* (13), and of basal distitarsi of *L. sibiriacum* (14), *L. baleicum* (15) and *L. laticeps* (16).

Metasoma: Tergal discs with PP fine but coarser than in female. Discs of T_1 and T_{2-3} anteriorly punctate, IS smooth and shiny, without striation. Visible sterna apically normal, not modified. Both S_7 and S_8 (Fig. 17) projecting medially. S_7 parallel-sided and apex rounded, S_8 triangular and apex rather pointed.



Figs. 17-18. Male terminalia of *L. subtropicum*. 17: Sterna 7 and 8, 18: Genitalia, dorsal (light) and ventral (left) views.

Genitalia (Fig. 18): Gonobase slightly shorter than $1/2$ width, slightly wider than $1/2$ gonocoxite width, lateral margins parallel. Gonocoxite with outer margin roundly outcurved, not continuing gonobasal contour. Gonostylus elongate, inner margin with finest setae, apical lobe oval, with moderately dense long hairs. Ventral retrose lobe

tongue-like, about as 3/4 long as gonocoxite, apically mildly pointed, densely and homogeneously haired ($\pm 25\mu$ long).

Specimens examined (all from Iriomote Is., Okinawa Prefecture, Kyushu).

Holotype 1Q (=queen): 11-14 iv, 1994, Y. Maeta (from a nest). Paratypes 6 W (=worker), 1♂, 2 iv, 1981, Y. Maeta (from nests, reared in lab.); 1Q, 2W, 25-26 iii, 1985, Y. Maeta and A. Yoshida (on nest site); 17Q, 2W, 5 iv, 1988 (on nest site), N. Sugiura; 2Q, 37W, 1♂, 11-14 iv, 1994, Y. Maeta (from nests, reared in lab.); 2Q, 10 W, 17♂, 23 iv, 1994, R. Miyanga (from nests, reared in lab.).

Type depository

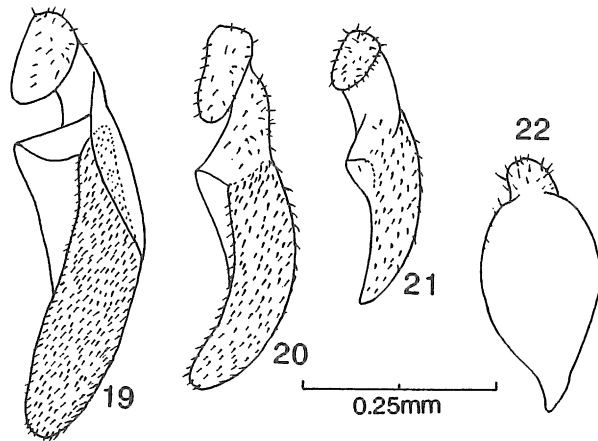
Holotype and some paratypes in Entomological Laboratory, Faculty of Agriculture, Kyushu University (Fukuoka), 1W, 2 iv, 1981. and 1♂, 12 iv, 1994, in A. W. Ebmer collection (Linz, Austria) and other paratypes temporarily in Sakagami (Sapporo) and Maeta (Matsue) collections (some ones will be deposited in Entomological Institute, Faculty of Agriculture, Hokkaido University, Sapporo, Entomological Laboratory, Faculty of Agriculture, Kyushu University (Fukuoka), etc.

Comparative Notes

L. subtropicum sp. nov. is remarkable because it is "carinaless" at the end of propodeal dorsum (Fig. 8), nevertheless it indubitably belongs to "the carinate *Evylaeus*" in both morphology and ethology. Before the discovery of males, Ebmer (pers. comm.) checked a female and assumed its affinity to the *L. laticeps*-*L. fulvicorne* group and further considered nearer to *L. laticeps* by its short head, raised supraclypeus and fine mesoscutal punctation (pers. comm.). However, male genitalia are evidently closer to *L. baleicum* (Cockerell, 1937) of the *L. fulvicorne* group (Ebmer pers. comm.), as well *L. sibiriacum* (Blüthgen, 1923) and *L. vulsum* (Vachal, 1903) which are, according to Ebmer (pers. comm.), intermediate between the *L. fulvicorne* and the *L. laticeps* groups, being quite different from *L. laticeps* (cf. Figs. 19-22). Here we regard *L. subtropicum* tentatively as a member of the *L. fulvicorne* group (s. lat.) involving both *L. sibiriacum* and *L. vulsum*. All these species have short head (Table 1) and supraclypeus distinctly raised. Main differences among these species and a circumpolar species *L. boreale* (Svenson *et al.*, 1977. see also Sakagami and Toda, 1986) with longer head but similar propodeum (Figs. 8 and 10) are synoptically given in Table 1. The precise interspecific relationship should be clarified through further studies, but it is certain that *L. subtropicum* intimately relates to *L. baleicum*, *sibiriacum* and *vulsum*.

L. (E.) catileps (*Halictus catileps* Blüthgen, 1926) from Simula, N. India (known 1♂ alone) has somewhat similar propodeum (Fig. 23) but seemingly belongs to *L. malachurum* group (Ebmer, pers. comm.). Such occasional appearance of the carinaless propodeum in the "carinate" *Evylaeus* gives another example of the difficulty of establishing a categorical supra-specific grouping in Halictinae (Sakagami and Tadauchi, 1995), as also shown in a gradual change in the elevation of supraclypeus and

constriction of male distitarsal base (Table 1). It is interesting to know the probable reduction of propodeal carina appeared at three peripheral areas of the distributional range covered by the carinate *Evylaeus*.



Figs. 19-22. Male gonostylus and ventral retrose lobe of *L. baleicum* (19), *L. subtropicum* (20), *L. sibiriacum* (21), *L. laticeps* (22).

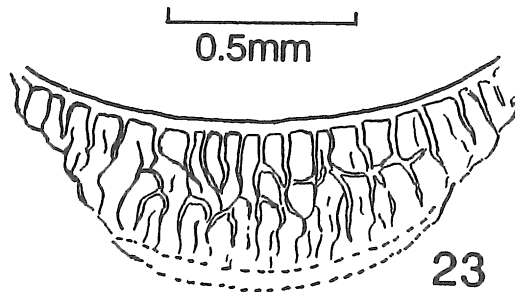


Fig. 23. Propodeal dorsum of *Lasioglossum catileps* ♂ (drawn from the unique type in Zoological Survey of India, Calcutta).

Morphometric inter-caste comparison among some social Halictinae

Figure 24 shows the relationship between head and metasomal widths of females of *L. subtropicum* collected on flowers with net or from nest entrances (numbers underlined) captured with aspirator. The size distribution is clearly bimodal corresponding to queens (larger ♀♀) and workers (smaller ♀♀).

Table 1. Synopsis of some morphological features of *L. sibiriacum* and allied species.

Character	<i>subtropicum</i>	<i>baleicum</i>	<i>sibiriacum</i>	<i>vulsum</i>	<i>boreale</i>
♀					
Head L/W	0.88	0.91	0.90	0.90	1.01
Hairs on PMA of T ₃	dense, obliquely postward directing	= <i>subtropicum</i>	dense, easily detachable, tomental hairs	= <i>subtropicum</i> , but sparser and more postward directing	= <i>subtropicum</i>
Tergal ends	distinctly and broadly pale and semitransparent	not distinctly pale and not semitransparent	distinctly and broadly semitransparent	= <i>sibiriacum</i>	broadly pale but not semitransparent
Supraclypeus	well raised	= <i>subtropicum</i>	slightly flatter	= <i>sibiriacum</i>	= <i>subtropicum</i>
Punctures on lower clypeus	not well developed	more developed	= <i>baleicum</i>	= <i>baleicum</i>	= <i>baleicum</i>
PP on mesoscutum medially	20-(25) $\mu\phi$, IS=0.5-1.0, finely tessellate	20-25 $\mu\phi$, IS=0.5-2.0, finely tessellate	coarse, often 30 $\mu\phi$, IS linear, distinctly granular	= <i>sibiriacum</i> , but PP generally finer; IS less granular, seen smoother	very weak, fine and sparse PP 15-20 $\mu\phi$, IS 1.0-2.0 or more
Apex of propodeal dorsum	well angulate but not carinate (Fig. 8)	well carinate (Fig. 9)	well carinate (Fig. 11)	= <i>sibiriacum</i>	well angulate but not carinate (Fig. 10)
♂					
Pale markings	yellow marks on clypeus, mandible, pronotal lobes and legs	concolorously black	= <i>subtropicum</i>	= <i>subtropicum</i>	= <i>subtropicum</i>
Ventral retrose lobe of genitalia	moderately long, hairs dense (Fig. 20)	longer and hairs sparser > <i>subtropicum</i> (Fig. 19)	shorter and hairs sparser > <i>subtropicum</i> (Fig. 21)	= <i>sibiriacum</i>	very short and hairs poor (cf. Svensson <i>et al.</i> , 1977, Fig. 7)
Hind distitarsus I	basally distinctly narrowed (Fig. 13)	= <i>subtropicum</i> (Fig. 14)	basally mildly narrowed (Fig. 15)	= <i>sibiriacum</i>	very short and basally distinctly narrowed (cf. Svensson <i>et al.</i> , 1977, Fig. 4)

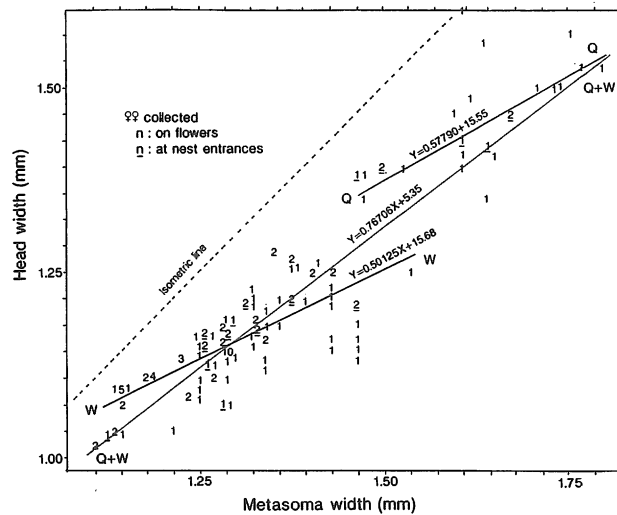


Fig. 24. Relationship between head width and metasomal width of *L. subtropicum* females (queens and workers). Three regression lines were calculated for workers (WW), queen (QQ) and for both combined (Q+W).

The number of bees collected from nest entrances was 7 out of 31 in queens while 16 out of 108 foragers. The difference is highly significant by χ^2 test ($P > 0.001$), favoring the hypothesis that more QQ may tend to act as guards than WW. However, this assumption can not be accepted uncritically. Many foragers must have stayed for a short period at the nest entrance before departures. The probability that they were counted as guards could be removed by more precise sampling as adopted by Sakagami (unpubl.) for *L. (E.) problematicum* (Blüthgen): The bee appeared at the entrance soon after the departure of a forager (or soon before the arrival of a forager), and stayed there for a while, or better, such bee who stayed at the entrance before and after the departure (or return) of a forager, was considered the real guard, and collected to check body size, mandibular wear and ovarian and spermathecal states. The results obtained by using this method will be described in a separate paper.

Next, the deviation from the isometric line was checked for queens and workers separately, as well as both jointly, by calculating regression lines. All 3 regression lines deviated from the isometric line, but line Q+W deviated less than lines Q and W. Deviations of these 2 lines from the isometric line was "isometric" from each other, despite the distinct difference in the absolute body size.

How the observed morphometric trend in *L. subtropicum* relates to that in some other social halictines was analyzed by comparing the sizes of various body parts in 7 selected species. Twenty-one characters measured are given in Fig. 25, lefthand, with abbreviations explained in Introduction, except for MdL (mandibular length including basal articulation. Fresh unworn females were used) and MdW (mandibular width).

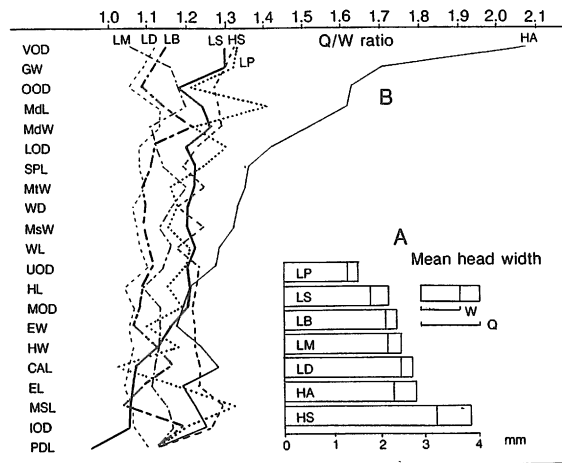


Fig. 25. Queen/Worker ratios in various body parts of 7 social halictine species *Halictus (Seladonia) aerarius* (HA), HS=*Halictus (H.) scabiosae*, LD=*Lasioglossum duplex*, LM=*L. malachurum*, LB=*L. baleicum*, LS=*L. subtropicum*, LP=*L. politum*. A: Mean head width of queens (Q) and workers (W), B: Various body parts were arranged in the descending order of Q/W ratios in HA.

The species compared are explained here as for the following items. 1- Abbreviation in Fig. 25. 2- Distribution. 3- Number of specimens measured. 4- Provenances and donors. 5- Criteria of QW distinction. The last item is not free from subjective judgment when the sample size is small and/or the size distribution is not clearly bimodal. Further measurements may be necessary in such cases.

A. *Halictus (Seladonia) aerarius* Smith, 1- HA, 2- Eastern Asia, 3- 10Q+10W, 4- Japan (Honshu), K. Fukushima, M. Matsuura, M. Yamada, 5- Season and size.

B. *Halictus (Halictus) scabiosae* Rossi, 1- HS, 2- Western Palaearctic, 3- 5Q+5W, France, C. Plateaux-Quénu, 4- Season and size.

C. *Lasioglossum (Evylaeus) subtropicum* sp. nov., 1- LS, 2- Endemic to Iriomote Is., Japan, 3- 10Q+10W, this study, 4- Size.

D. *L. (E.) duplex* (Dalla Torre), 1- LD, 2- Endemic to Japan, 3- 10Q+10W, Honshu and Hokkaido, K. Goukon, Y. Haneda, S. F. Sakagami, 4- Season.

E. *L. (E.) baleicum* (Cockerell), 1- LB, 2- Eastern Asia, 3- 10Q+10W, N. Honshu and Hokkaido, S. F. Sakagami, M. Yamada, 4- Season.

F. *L. (E.) malachurum* (Kirby), 1- LM, 2- Western Palaearctic, 3- 4Q+8W, France and Balkan Pen., C. Plateaux-Quénu, A. W. Ebmer, 4- Size and season.

G. *L. (E.) politum* (Schenck), 1- LP, 2- Transpalaearctic, 3- Western ssp. *politum*, 4Q+1W, Austria, Jugoslavia, A. W. Ebmer, Eastern ssp. *pekingense* (Blüthgen), 2Q+4W, Japan (Honshu), Y. Haneda, H. Takahashi, K. Yamauchi. 4- Size. In this species the results of 2 ssp. were clustered. Here the terms Q and W are still tentative.

Figure 25A shows the mean head width of Q and W of studied species in the ascending order. In Fig. 25B, first the obtained Q/W ratios of various body parts in *H. aerarius*, who showed the highest allometric size difference, were arranged in the

descending order. Then, Q/W ratios in the other species were plotted in the same order. The seven studied species can be classified in 3 groups. I - HA and HS, II- LS, LB, LM, LD and III- LP alone.

In Group I both species are megacephalic, HS is less exaggerated than HA but at least the top-given characters from VOD to LOD, all related to megacephaly, show a trend similar to that in HA.

Interestingly, some *Halictus* species develop a conspicuous megacephaly in queens, e. g., *H. (Seladonia) hesperus* (Sakagami and Moure, 1965) and *H. (H.) latisignatus* (Sakagami and Wain, 1966), nevertheless the social level of this genus is generally lower than in social species of *Lasioglossum (Evylaeus)* (Sakagami, 1974; Knerer, 1980). It is likely that megacephaly sometimes relates to the lasting guarding at the nest entrance, as actually confirmed in *H. scabiosae* (Fabre, 1882; Quénu, 1957) and *H. aerarius* (Sasaki, 1985; cf. also Sakagami and Fukushima, 1961).

On the other hand, Litte (1977) found in *H. (H.) ligatus* that the large female (\cong Q) functioned as primary egg-layer and guard in the spring semisocial colonies, and this continued to the summer with occasional foraging. However, daughters (\cong W) also participated in guarding in various degrees. It is likely that such plasticity gradually decreases in the species with exaggerated megacephaly, though precise comparative observations are necessary.

Possibly a similar trend exists in some halictine species of Augochlorini, because some species exhibit a remarkable megacephaly (Sakagami and Moure, 1966) despite so far known social levels in this tribe are generally lower than in Halictini (Eickwort and Sakagami, 1979).

All 4 species of Group II belong to the carinate *Evylaeus*, many bionomically studied species of which have fairly developed social structure. Except *L. subtropicum*, whose life cycle is not yet well known, the other 3 cited species are all characterized by a neat segregation of spring solitary phase and summer eusocial phase, with advanced functional QW differentiation: *L. duplex*, Sakagami and Hayashida, 1961, 1968; *L. malachurum*, Fabre, 1882; Legewie, 1922; Stöckhert, 1923; Noll, 1931; Bonelli, 1948; *L. baleicum* (Sakagami *et al.*, unpubl.). Nevertheless, their morphological caste differentiation is clearly lower than in Group I species and they exhibit virtually no conspicuous queen megacephaly as shown in Fig. 25. Table 2 gives mean Q/W ratios of 21 measured characters in 7 species. Two Group I species occupy the 2 top ranks, followed by *L. subtropicum* but the 3 *Evylaeus* species with a clear functional caste differentiation are lowest ranked. It is noteworthy that the mean Q/W ratio of *L. subtropicum* is much higher than that of *L. malachurum* of which summer females (workers) are so small that first described as an independent species (*Halictus longulus* Smith). Although *L. malachurum* was studied bionomically by several authors, none of them definitively stated "continuous" guarding by the queen at the nest entrance as confirmed in *H. scabiosae* but *H. aerarius*. In *L. duplex* the absence of continuous guarding by the queen at nest entrance was confirmed through selective sampling described in p. 14. In *L. baleicum* such method was not yet applied but guarding seems to be practiced mainly by workers. Table 3 gives a Q/W comparison of the ratios between 2 measured values which are either length and width of the same

Table 2. Mean queen/worker ratio of 21 measured characters in 7 social halictine species, arranged in the descending order.

Group	Species	Mean ratio
I	<i>Halictus (Seladonia) aerarius</i>	1.32 ± 0.27
I	<i>H. (Halictus) scabiosae</i>	1.23 ± 0.05
II	<i>Lasioglossum (Evylaeus) subtropicum</i>	1.22 ± 0.04
III	<i>L. (E.) politum</i>	1.21 ± 0.09
II	<i>L. (E.) malachurum</i>	1.13 ± 0.04
II	<i>L. (E.) baleicum</i>	1.11 ± 0.04
II	<i>L. (E.) duplex</i>	1.07 ± 0.03

part, or those (or distances) of 2 adjacent parts (mostly related to cephalic allometry) in 7 studied species. In most species Q/W ratios are within 1.00-1.09, *i. e.*, nearly isometric between castes, somewhat similar to the Q/W relation seen in Fig. 23. Only in *H. aerarius*, all Q/W ratios are more than 1.10. Otherwise only 4 ratios in *L. politum* and each one in *H. scabiosae* and *L. subtropicum* are 1.10 or more, whereas all 3 other *Lasioglossum* are virtually isometric between Q and W. In other words, the castes in these species are functionally well differentiated but is morphometrically rather isometric between them, even though differing in the absolute body size.

Finally a few words are given for *L. politum*, the only studied member of Group III, because: 1- This species is the only known social species (excluding communal ones) in the carinaless *Evylaeus* (with a possible exception of *L. glabriusculum*, Knerer, 1969; Ebmer, 1985). 2- However, its sociality is still not well studied, only recorded as "Diese winzige Art ist sozial und hat eine Sommerbrut von Arbeiterinnen, die im mütterlichen Nest bleiben" (Knerer, 1968). 3- On the other hand, its large (\approx Q) and small (\approx W) females exhibit a notable allometric differences (Figs. 26-29). The large females even somewhat resembles the gigantic males of the species in the *L. (Evylaeus) sexstrigatum* group, *e. g.*, *L. ohei* (Sakagami *et al.*, 1966), though obviously less bizarre. Both Quénu (1954) and Knerer (1968) wrote on the long turrent (1.5-2.0cm) prepared on the nest entrance of this species, but did not mention any relation between this elaborated construct and peculiar head of large females. According to these authors and Ebmer (1988), this species seems quite abundant in some area in Europe. Its bionomic studies must enrich our knowledge on the halictine social spectrum.

This species has only sporadically known from Japan. Ebmer (1988) mentioned its occurrence there as ssp. *pekingense* (Blüthgen, 1925), without citing collecting records. The specimens examined by one of us (S. F. S.) are as follows (all from central Honshu, Japan): Nakatoh, Musashi Murayama, Tokyo, vii 3 1986, 1W, x 20 1986, 1Q, H. Takahashi; Minami, Gifu Prefecture, vii 28 1970, 2W, viii 11 1970, 1W, K. Yamauchi, Y. Murakumo, M. Ogura; Tama cemetery, Fuchu, Tokyo, vii 28 1993, 1Q, 1♂, T. Nambu. Unlike 5 European females compared, all Japanese specimens had metasoma (except black T₁ base) entirely or partly reddish brown.

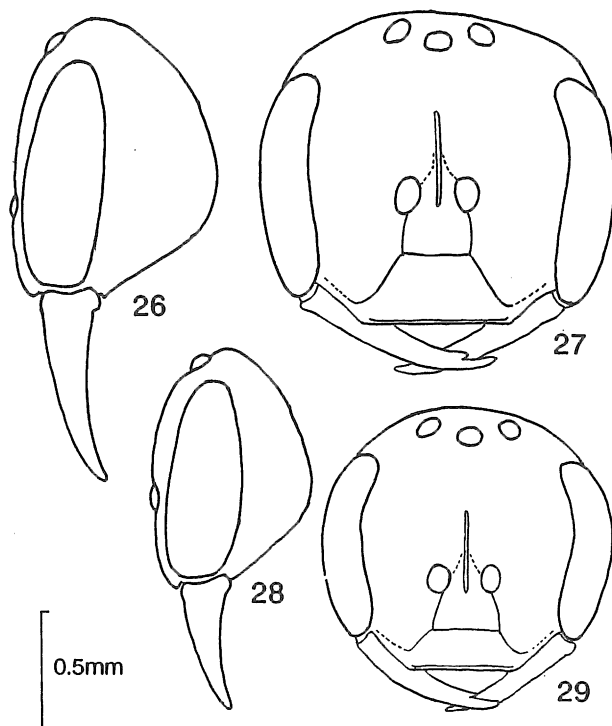
Table 3. Interspecific comparison of 7 part/part ratios between castes.

Part/Part ratio ^{1), 2), 3)}	<i>H. aerarius</i>		<i>L. politum</i>		<i>H. scabiosae</i>		<i>L. subtropicum</i>		<i>L. malachurum</i>		<i>L. baleicum</i>		<i>L. duplex</i>								
	Q	W	Q/W	Q	W	Q/W	Q	W	Q/W	Q	W	Q/W	Q	W	Q/W						
VOD/IOD	1.62	0.76	2.13	0.77	0.70	1.10	1.37	1.30	1.05	0.66	0.63	1.08	0.71	0.73	0.97	0.71	0.73	0.97	0.74	0.70	1.06
OOD/IOD	1.52	0.93	1.63	0.93	0.91	1.02	1.27	1.26	1.01	0.84	0.85	0.99	0.84	0.93	0.90	0.84	0.93	0.90	0.90	0.89	1.01
GW/EW	1.71	1.16	1.47	1.10	0.92	1.20	1.81	1.70	1.06	1.29	1.16	1.11	1.19	1.13	1.05	1.19	1.13	1.05	1.03	0.99	1.04
MdL/UOD	0.84	0.65	1.29	0.85	0.73	1.16	0.90	0.86	1.05	0.73	0.78	0.94	0.73	0.72	1.01	0.66	0.62	1.06	0.67	0.62	1.08
VOD/CAL	0.70	0.56	1.25	0.51	0.39	1.30	0.34	0.31	1.10	0.35	0.34	1.03	0.35	0.35	1.00	0.35	0.35	1.00	0.30	0.28	1.07
MtW/HW	0.96	0.80	1.20	1.07	1.08	0.99	1.09	1.07	1.02	1.13	1.14	0.99	1.15	1.19	0.97	1.15	1.17	0.98	1.17	1.14	1.03
LOD/UOD	1.03	0.91	1.13	0.99	0.92	1.08	1.06	1.06	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.09	1.08	1.01	1.06	1.09	0.97

1) Abbreviations are explained in Introduction except MdL (=mandible length).

2) Q/W ratios 1.10 or more are shown with gothic.

3) Ratios given in the descending order in Q/W of *H. aerarius*.



Figs. 26-29. Lateral (26, 28) and frontal (27, 29) views of large (26, 27) and small (28, 29) females of *Lasioglossum (Evylaeus) politum*.

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