

Larval morphology of the Taiwan endemic *Rhantus formosanus* KAMIYA (Coleoptera: Dytiscidae)

Y. ALARIE & L.-J. WANG

Abstract

The second and third instars of *Rhantus formosanus* KAMIYA (Coleoptera: Dytiscidae) are described and illustrated. This species has turned out as very similar to other known species of *Rhantus* DEJEAN in terms of larval morphology except for the presence of natatory setae on coxae. The mature larva of *R. formosanus* can readily be differentiated from that of the cosmopolitan species *R. suturalis* (MACLEAY), the only other known species of *Rhantus* from Taiwan, by the presence of 23 - 27 spine-like setae along the outer margin of urogomphus and its larger size.

Key words: Coleoptera, Dytiscidae, Colymbetinae, larva, chaetotaxy, Taiwan.

Introduction

The dytiscid genus *Rhantus* DEJEAN is comprised of 97 species worldwide, nine of which have been recorded from China (NILSSON 1995, 2001). *Rhantus* is represented in all major zoogeographic regions as well as on many oceanic islands. Those beetles occur in shallow, plant-lined margins of pools and marshy areas (ZIMMERMAN & SMITH 1975).

In term of classification, *Rhantus* is treated as a member of the subfamily Colymbetinae which contains 10 genera worldwide (NILSSON 2001). Due largely to the great diversity of the Colymbetinae, intergeneric relationships of members of the subfamily are not well known. Recent study on larval morphology of these taxa, however, suggests a closer phylogenetic relationship of *Rhantus* s.lat. with members of *Colymbetes* CLAIRVILLE and *Neoscutopterus* BALFOUR-BROWNE (ALARIE 1995, 1998). NILSSON & HILSENHOFF (1991) postulated that *Rhantus* s.lat. probably is not a natural group.

The larval morphology of most *Rhantus* species is still poorly known. Worldwide, the larvae of 16 species have been described and/or figured, in most cases very superficially (MEINERT 1901; WILLIAMS 1936; BERTRAND 1928; GALEWSKI 1963; WATTS 1963; JAMES 1969; BARMAN 1972; NILSSON 1987; COSTA et al. 1988; KLAUSNITZER 1991). Except for *R. fennicus* HULDÉN (NILSSON 1987), none of these descriptions used chaetotaxy as a diagnostic feature. Recent studies on larvae of Colymbetinae have indicated the usefulness of this character set (ALARIE 1995, 1998; ALARIE & BALKE 1999; ALARIE & LARSON 1998; ALARIE et al. 1998; SHAVERDO 2003) both from a phylogenetic and diagnostic perspective.

The recent discovery of the larvae of *Rhantus formosanus* KAMIYA, an endemic species of Taiwan (see NILSSON et al. 1995), provided the impetus for this study. More specifically it aims at describing the second and third instars of *R. formosanus* and to position this species in the actual context of the larval morphology of the genus *Rhantus*. This paper is one of several forthcoming papers of the senior author dealing with the larval morphology of the Colymbetinae using the descriptive format provided in recent studies of larvae of this group of beetles (e.g., ALARIE & BALKE 1999; ALARIE & LARSON 1998; ALARIE et al. 1998; SHAVERDO 2003).

Material and methods

The second instar (6 exs.) and third instar (7 exs.) of *Rhantus formosanus* were collected in association with adult in Taiwan: Nantou, Tzuchung, 24.ix.1994.

The methods, terminology, and format of this paper follow those of recent studies on larval morphology of the Colymbetinae (ALARIE et al. 1998, ALARIE & LARSON 1998, ALARIE & BALKE 1999). Some of the acronyms used in this paper (AL = length of antenna, MndL = length of mandible; MndW = width of mandible; GaL = length of galea; StpL = length of maxillary stipes) are from SHAVERDO (2003). Specimens representative of each of the two instars were disarticulated and mounted on standard glass slides with Hoyer's medium. Examination at magnifications of 80-800 X was done using an Olympus BX50 compound microscope equipped with Nomarsky differential interference optics. Voucher specimens are deposited in the research larval collection of Y.A. (Laurentian University, Department of Biology, Sudbury, Ontario, Canada).

Primary and secondary setae and pores were distinguished on the cephalic capsule, head appendages, legs, last abdominal segment, and urogomphi. The setae and pores are coded according to the systems proposed by ALARIE (1995) for the legs, the last abdominal segment, and urogomphi and ALARIE (1998) for the cephalic capsule and head appendages. Instar I larvae of the genus *Rhantus* are characterized by the presence of additional setae on femora and tibiae (ALARIE 1995). Since no instar I of *R. formosanus* was available for this study the number of additional setae could not be determined and accordingly, the primary setae were included in the count of secondary setae.

Rhantus formosanus KAMIYA, 1938

DESCRIPTION, Instar III ($n = 3$):

Colour (alcohol preserved specimens): Head capsule yellow to pale brown laterally; frontoclypeus with a three-forked brownish pattern mesally; parietal with a reticulate brownish pattern mesally; head appendages pale brown; thoracic terga predominantly yellow with several brownish maculae; legs yellow to pale brown; abdominal terga yellow to pale brown with a variable number of dark brown maculae; urogomphus yellow.

Head (Fig. 1): HL = 2.85 - 2.88 mm (mean = 2.86 mm); HW = 2.80 - 3.03 mm (mean = 2.93 mm); FCL = 1.13 - 1.20 mm (mean = 1.18 mm). Cephalic capsule rounded to subquadrate, as broad as long (HL/HW = 0.94 - 1.03), strongly constricted posteriorly, HW/OcW = 1.74 - 1.81; ecdysial suture well-developed, coronal suture short, 0.58 - 0.61 times HL; occipital suture present; frontoclypeus strongly convex mesally, 0.39 - 0.42 times HL, extending medially at about level of lateral lobes [= adnasalia]; apical margin of frontoclypeus with several club-shaped setae [lamellae clypeales of BERTRAND (1972)] variable in size; gular suture visible; ocellularium present, stemmata visible ventrally and subdivided into two vertical series; tentorial pits visible ventrally on each side of middle at about midlength. Antenna: AL = 1.56 - 1.60 mm (mean = 1.58 mm); four-segmented, shorter than HW; (AL/HW = 0.53 - 0.56); A1 = A2 > A3 = A4, A2/A3 = 1.16; lateral elongation of antennomere 3 pore-like; antennomere 3 with a ventroapical spinula. Mandible falciform, MndL/MndW = 2.74 - 2.98; MndL/HL = 0.50 - 0.52; mandibular channel present, pubescence developed along inner margins, serrate ventrally along a short distance. Maxilla: Stipes subrectangular, short and thick; cardo and galea present, lacinia lacking; StpL = 0.42 - 0.45 mm (mean = 0.43 mm), Stpl/length of maxillary palpus = 0.34 - 0.37; GaL = 0.18 - 0.20 mm (mean = 0.19 mm), 0.37 - 0.41 times length of maxillary palpomere 1; palpus length = 1.21 - 1.24 mm (mean = 1.23 mm), three-segmented; AL/length of maxillary

palpus = 1.27 - 1.32; palpomere 1 > 2 > 3, length of palpomere 3/ length of palpomere 2 = 0.79 - 0.83. Labium: Prementum subrectangular, broader than long, slightly sinuated mesally; palpus two-segmented; palpus length = 0.86 - 0.89 mm (mean = 0.87 mm); length of maxillary palpus/length of labial palpus = 1.39 - 1.43; palpomere 2 0.70 - 0.76 as long as palpomere 1. Chaetotaxy: Head capsule with several secondary setae, lateral margin of parietal with 16 - 18 spines; head appendages lacking secondary setae except mandible with several tiny secondary setae (pore-like at lower magnifications).

Thorax: Pronotum trapezoidal dorsally, ovate laterally, widest at posterior margin; length of pronotum about twice that of mesonotum; metanotum subequal to mesonotum in length, both as broad as pronotum; pronotum with a posterotransverse carina; meso- and metanota both with antero- and posterotransverse carina; maximum body width at level of meso- and metathorax; thoracic venter membranous; spiracular openings present anterolaterally on mesothorax.

Legs (Figs. 3 - 6): Five-segmented; metathoracic legs longest, about 1.30 times length of prothoracic legs, and 2.50 times HW; coxa = femur > tibia = tarsus > trochanter; tarsus with two claws, posterior claw slightly shorter than anterior claw on pro- and mesothoracic legs, slightly longer on metathoracic leg; anterior metathoracic claw 0.37 - 0.39 times as long as metatarsus; spinulae on ventral margin of tibia and tarsus strongly developed; tarsal claws with a reduce number of spinulae ventroproximally. Chaetotaxy: Position and number of secondary setae as shown in Table 1.

Abdomen (Fig. 2): Eight-segmented; LLAS = 1.98 - 2.20 mm (mean = 2.09 mm); dorsally sclerotized; segments 1 - 6 membranous ventrally, segments 7 and 8 completely sclerotized; terga 1 - 7 with antero- and posterodorsal transverse carina, tergum 8 with an anterodorsal transverse carina only; segments 1 - 7 with a pair of spiracular openings; segment 8 subcylindrical, LLAS/HW = 0.67 - 0.73, abruptly narrowing posterior to insertion of urogomphi; siphon 0.20 - 0.24 times as long as LLAS, shortly sinuated mesally. Chaetotaxy: Secondary setae predominantly short and spine-like.

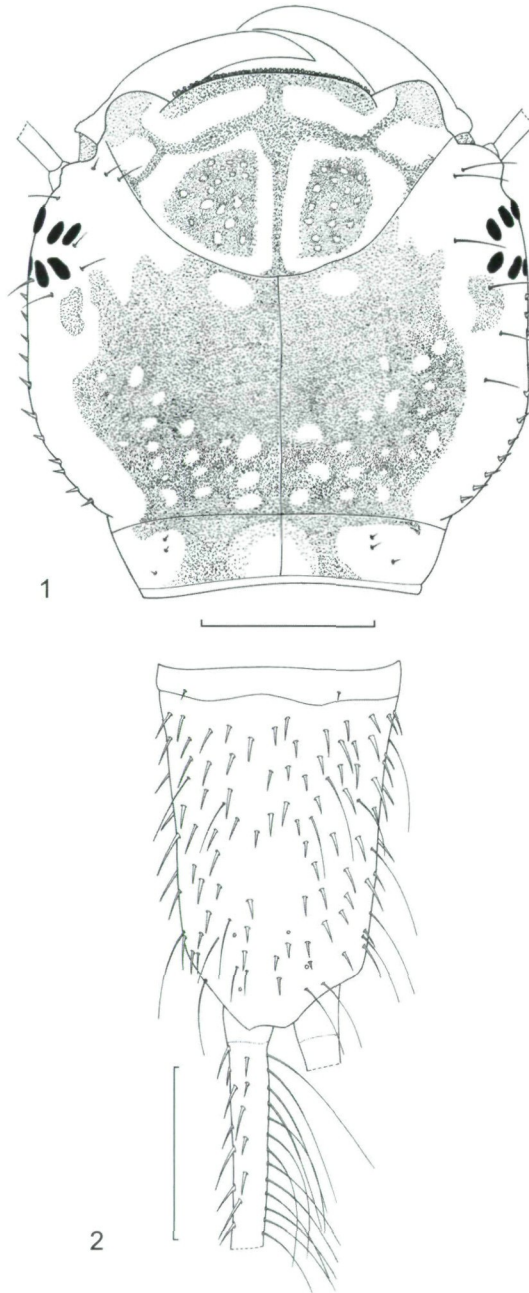
Urogomphus (Fig. 4): One-segmented, with subbasal suture present; total length of urogomphus = 2.75 - 3.00 mm (mean = 2.91 mm), 1.25 - 1.52 times as long as LLAS, and 0.91 - 1.06 times as long as HW. Chaetotaxy: Inner margin with 28 - 38 hair-like natatory setae; outer margin with 22 - 34 spine-like secondary setae (some more dorsally articulated).

DESCRIPTION, Instar II ($n = 4$):

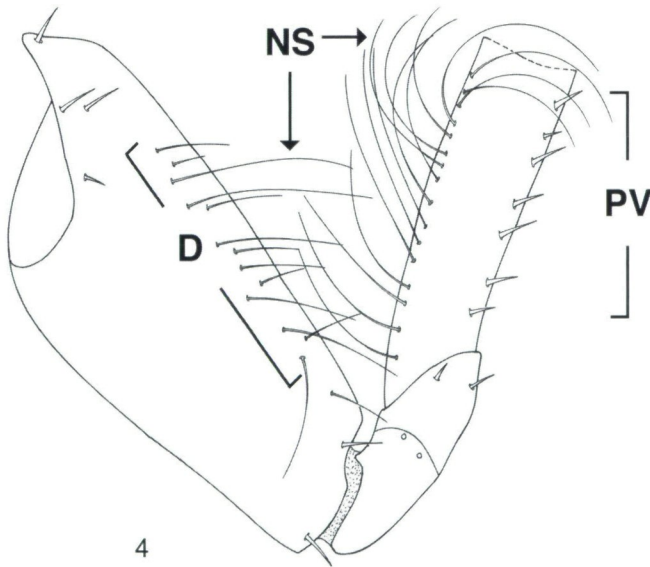
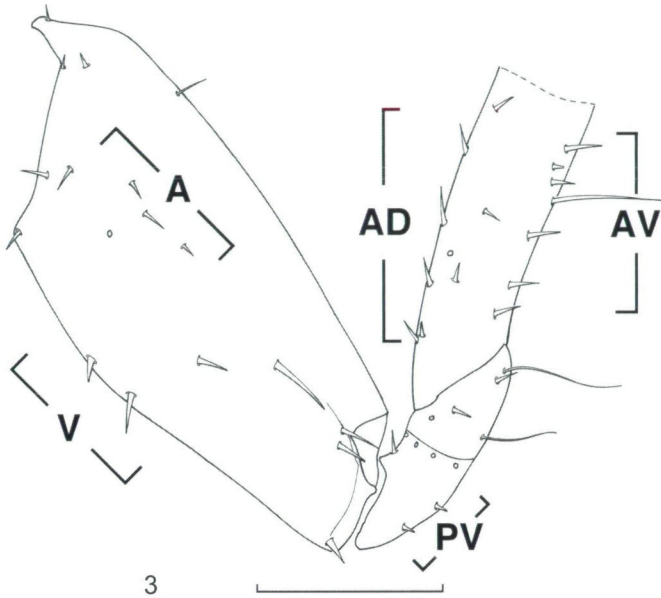
Colour as for instar III.

Head: HL = 1.83 - 2.00 mm (mean = 1.89 mm); HW = 1.86-1.98 mm (mean = 1.91 mm); FCL = 0.80 - 0.82 mm (mean = 0.81 mm). Cephalic capsule: HL/HW = 0.97 - 1.01, HW/OcW = 1.83 - 1.99; coronal suture 0.56 - 0.59 times HL; frontoclypeus strongly convex mesally, 0.41 - 0.44 times HL. Antenna: AL = 1.19 - 1.24 mm (mean = 1.21 mm); AL/HW = 0.61 - 0.67; A1 = A2 = A3 = A4, A2/A3 = 0.98 - 1.06. Mandible: MndL/MndW = 2.61 - 2.63; MndL/HL = 0.50 - 0.54. Maxilla: StpL = 0.27 - 0.28 mm (mean = 0.27 mm), Stpl/length of maxillary palpus = 0.29 - 0.30; GalL = 0.12 - 0.13 mm (mean = 0.13 mm), 0.40 - 0.43 times length of maxillary palpomere 1; palpus length = 0.91 - 0.92 mm (mean = 0.92 mm); AL/length of maxillary palpus = 1.30 - 1.36; palpomere 1 = 2 = 3, length of palpomere 3/length of palpomere 2 = 0.92 - 0.98. Labium: Palpus length = 0.64 - 0.68 mm (mean = 0.66 mm); length of maxillary palpus/length of labial palpus = 1.34 - 1.42; palpomere 2 0.89 - 0.97 as long as palpomere 1. Chaetotaxy: Head capsule with several secondary setae, lateral margin of parietal with 13 - 17 secondary spines; head appendages lacking secondary setae except mandible with several tiny secondary setae (pore-like at lower magnifications).

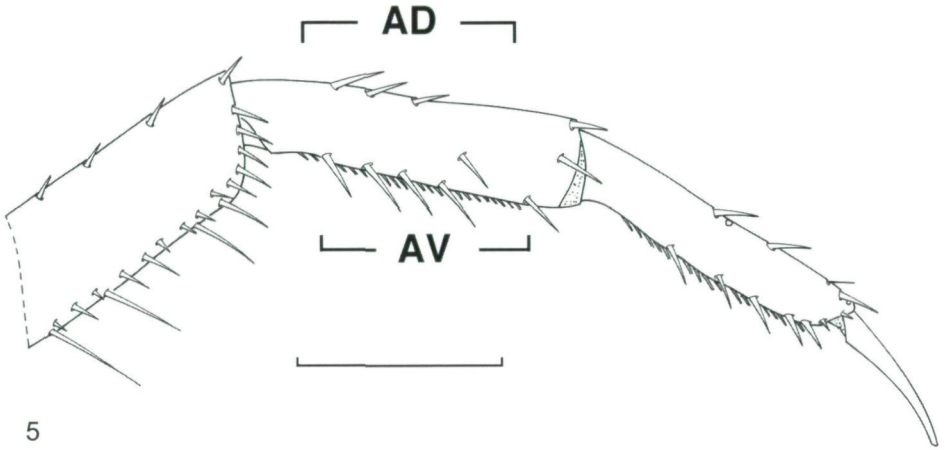
Thorax: Spiracular openings absent.



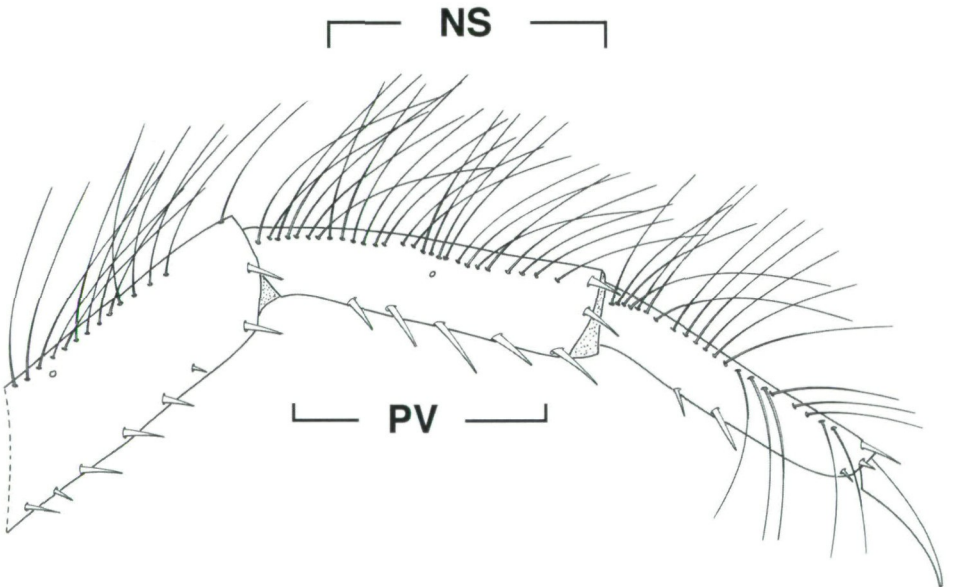
Figs. 1 - 2: *Rhantus formosanus*, dorsal aspect, third instar (1) cephalic capsule; (2) last abdominal segment. Scale bar = 1.0 mm.



Figs. 3 - 4: Metacoxa, metatrochanter, metafemur of *Rhantus formosanus*, third instar: (3) anterior surface, (4) posterior surface; A = anterior, AV = anteroventral, AD = anterodorsal, NS = natatory setae, Pr = proximal, PV = posteroventral. Scale bar = 0.5 mm.



5



6

Figs. 5 - 6: Metafemur, metatibia, and metatarsus of *Rhantus formosanus*, third instar: (5) anterior surface, (6) posterior surface; AD = anterodorsal, AV = anteroventral, NS = nataory setae, PV = posteroventral. Scale bar = 0.50 mm.

Legs: Metathoracic legs about 1.30 times length of prothoracic legs, and 2.60 times HW; coxa = femur > tibia = tarsus > trochanter; anterior metathoracic claw 0.41 - 0.46 times as long as metatarsus; spinulae on ventral margin of tibia and tarsus strongly developed. Chaetotaxy: Position and number of secondary setae as shown in Table 1.

Abdomen: LLAS = 1.31 - 1.43 mm (mean = 1.36 mm); spiracular openings absent; LLAS/HW = 0.69 - 0.75. Siphon 0.19 - 0.22 times as long as LLAS, shortly sinuated mesally. Chaetotaxy: Secondary setae predominantly short and spine-like.

Urogomphus: Total length of urogomphus = 2.05 - 2.28 mm (mean = 2.15 mm), 1.44 - 1.67 times as long as LLAS, and 1.08 - 1.15 times as long as HW. Chaetotaxy: Inner margin with 26 - 31 hair-like natatory setae; outer margin with 23 - 27 spine-like secondary setae (some more dorsally articulated).

Table 1: Number of secondary setae (including additional setae, cf. material and methods) on the legs of the second and third instars of *Rhantus formosanus*.

A = anterior, AD = anterodorsal, AV = anteroventral, CO = coxa, D = dorsal, FE = femur, NS = natatory setae, PD = posterodorsal, Pr = proximal, PV = posteroventral, TA = tarsus, TI = tibia, TR = trochanter, V = ventral, *n* = number of specimens studied, range = total number of secondary setae on segment.

Segment	Sensillar series	Second instar (<i>n</i> = 3)	Third instar (<i>n</i> = 6)
ProCO	D(NS)	12	15-19
	A	5-7	4-9
	V	2-3	3-4
	Total	19-22	24-27
ProTR	Pr	1	1-2
ProFE	AD	8-11	11-13
	AV	12-13	18-19
	PD(NS)	13-17	26-28
	PV	8-9	7-11
	Total	41-51	64-69
ProTI	AD	3-4	2-4
	AV	4-6	5
	PD(NS)	15-18	25-26
	PV	3-4	4
	Total	26-31	37-41
ProTA	AD	2-3	2-3
	AV	6	5-6
	PD(NS)	14-15	21-24
	PV	2	1-2
	Total	24-26	31-32
MesoCO	D(NS)	8-10	12-14
	A	4-5	7-14
	V	2-4	4-7

	Total	16-18	28-31
MesoTR	Pr	1	2-3
MesoFE	AD	12-13	12-14
	AV	11-12	012-14
	PD (NS)	14-17	23-24
	PV	8-10	11-12
	Total	45-52	60-61
MesoTI	AD	5	6
	AV	8-9	6-9
	PD (NS)	15-20	27-31
	PV	3	3-5
	Total	31-37	43-50
MesoTA	AD	3-4	3
	AV	6-8	7-8
	PD (NS)	15-18	26-29
	PV	3	2-3
	Total	28-31	39-42
MetaCO	D(NS)	5-7	10-13
	A	3-5	7-9
	V	5-6	5-6
	Total	15-17	23-27
MetaTR	Pr	1-2	2-3
MetaFE	AD	12-13	15-18
	AV	11-13	12-13
	PD(NS)	6-8	12-13
	PV	7	10-13
	Total	36-41	49-59
MetaTI	AD	6	8-10
	AV	7-8	8-9
	PD(NS)	15-17	27-28
	PV	3-4	3-4
	Total	32-35	48-49
MetaTA	AD	3-5	4-5
	AV	6-8	9
	PD(NS)	17	30-31
	PV	1-3	2-3
	Total	27-32	46-47

Discussion

Larvae of *Rhantus formosanus* are described in detail for the first time in this contribution. This species has turned out as very similar to other known species of *Rhantus* in terms of larval morphology. Like other species of *Rhantus*, the larvae of *R. formosanus* are easy to separate from those of other genera of Colymbetinae except the larvae of *Colymbetes*. Both these genera are characterized by elongate head appendages, presence of ventrobasal spinulae on tarsal claws (a feature shared with *Neoscutopterus*), and presence of numerous natatory setae on legs. Larvae of *Rhantus*, however, are distinguished from those of *Colymbetes* by their smaller size [with exception of *C. minimus* ZAITZEV (SHAVERDO 2003)], a slightly narrower head capsule, and a slightly longer abdominal segment 8. Instar II and III of *R. formosanus* (as well as those of other species of *Rhantus*) can also be distinguished from those of *Colymbetes* by the number of secondary setae present on the posterodorsal margin of the metafemur. Instar II and III of *R. formosanus* have less than eight and 13 setae respectively (cf. Table 1) instead of more than 15 and 30 setae in *Colymbetes*. The presence of numerous secondary setae on the urogomphus is characteristic of most species of Colymbetini (NILSSON & HILSENHOFF 1991).

The mature larva of *R. formosanus* can readily be differentiated from that of the cosmopolitan species *R. suturalis* (MACLEAY), the only other known species of *Rhantus* from Taiwan, by the presence of 23 - 27 spine-like setae along the outer margin of urogomphus [less than 5 in *R. suturalis* (NILSSON 1987)] and the larger size [HL > 2.80 mm compare to < 2.40 mm in *R. suturalis* (NILSSON 1987)].

The coxa of *R. formosanus* is characterized by the presence of elongate natatory setae along the dorsal margin (Fig. 4). This is the first report of presence of coxal natatory setae in *Rhantus* larvae.

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