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その他（別言語等）のタイトル	先球毛を欠く4種のArctosa属のコモリグモおよびそれらの子における出のう後の行動
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Four *Arctosa* Lycosids Lacking the Abdominal Knobbed Hairs and their Pulli's Post-emergent Behaviour (Araneae, Lycosidae)

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先球毛を欠く4種の *Arctosa* 属のコモリグモおよびそれらの子における出のう後の行動

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概　要

先球毛 knobbed hairs は Graefe (1964) で報告されてから現在にいたるまで，コモリグモ科の成雌個体だけから発見され，またコモリグモ科の成雌個体であればかならず確認されてきた特殊な腹毛である。一方コモリグモ科の成雌は子の集団を腹部にのせるという，クモ類にあっては特異な方法（子守行動）で子を保護することが知られている。そのため Rovner ら (1973) はこの毛の先端にある球体が子の腹部へのとりつきを誘発する構造的な信号としての作用をもち，かつとりつきの足場としても先球毛は重要であると考えた。

著者はすでに2種の *Arctosa* 属のコモリグモにおいて，出のう後の子に母グモの腹部にとりつく本能がないこと，またこれらの母グモの腹部は子のとりつきに適さないことを実験的に確認し報告した (Fujii, 1976, 1980)。子のとりつきに適さない性質はおそらく先球毛を欠くことによると考えられたので，子守行動のみられる別の2種の *Arctosa* 属のクモとともに，今回これらのクモの成雌の腹毛を走査電顕で調査した。その結果，子守行動の有無にかかわらず，それらの腹毛はすべて先端の球体を欠いていることがわかった。しかし子守のみられる2種の腹毛は，典型的な先球毛と同様に屈曲が強く，腹表に多数のアーチを形成していることが認められた。したがって先球毛の重要性は先端の球体にあるのではなく，強く屈曲してアーチとなることにより，子グモが歩脚の爪をかける足場を提供する点にあると判断された。

先球毛の球体の形状は，これを欠く場合も含めて属間で異なるが属内では一定しているようだ。したがって機能上の意義は少ないとしても，コモリグモ科内の系統学的類縁関係を知るためには有効な対象かもしれない。

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ABSTRACT

The abdominal hairs of the adult females of four *Arctosa* lycosid species were examined with a scanning electron microscope. Then it was revealed that none of them have the knobbed hairs, which are peculiar to adult female lycosids and have been regarded as the trigger of the clinging response of pulli onto the mother's abdomen. The normal pulli-carrying behaviour, however, was observed in two species of them.

INTRODUCTION

A mother of wolf spiders (Araneae, Lycosidae) attaches its egg cocoon to spinnerets. The pulli (the youngs) emerge out of a cocoon just after the moulting to the first nymphal stage, then they stay on the mother's abdomen till their dispersion. The regulating mechanisms in this period have been investigated with various experimental techniques. Some problems to be solved, however, are still left. One of them is the role of the knob-tipped abdominal hairs.

Graefe (1964) found the knobbed hairs in all adult females of eighteen lycosid species he examined, but he could not find them in male or larval lycosids and in adult females of the closely related family, Pisauridae; therefore he inferred that the knobbed hairs relate to the maternal care that is peculiar to lycosid spiders. Rovner et al. (1973) examined the role of knobbed hairs in *Lycosa rabida* Walck. and *L. punctulata* Henz, and they regarded the knobbed hairs as the trigger of the pulli's clinging behaviour and as the grasping structure for the inner layer of pulli. This conception means that the lycosid pulli recognize instinctively the site to climb and settle on, so conflicts with a lot of reports showing that a mutual recognition between the lycosid mother and its pulli does not exist (Eason, 1964; Engelhardt,

1964; Fabre, 1971; Fujii, 1980; Higashi and Rovner, 1975; Meyer, 1928).

Fujii (1976) reported that the pulli of *Arctosa* sp.* and *A. ebicha* Yaginuma disperse without settling on mother's abdomen. It had been expected that the females in these lycosids have not the knobbed hairs on the abdomen. This paper reports the result of scanning electron microscopical examinations of the female abdominal hairs both in the above two *Arctosa* lycosids and in two additional lycosids, *A. subamylacea* (Boes. et Str.) and *A. depectinata* (Boes. et Str.), whose pulli climb and settle on the mother's abdomen normally. The behaviour of the pulli in the latter two species were re-examined and will be also reported.

MATERIALS AND METHODS

All materials were collected from the field in Hidaka-machi, Iruma-gun, Saitama pref., in 1981–2. The females of *Arctosa* sp. and *A. ebicha* were immediately fixed and preserved in 70% ethanol. The females of *A. subamylacea* and *A. depectinata* were reared in the laboratory to examine the behaviour of their pulli after the emergence. A small glass tube (15×100mm) with a wad of dry cotton at the mouth and with soaked one at the bottom was used for each rearing and examination. These glass tubes were laid under a fluorescent tube and illuminated at a light intensity of about 1500 lux during the day-time. The bottom half of each glass tube was covered with a sheet of alminium to make a dark part, since these lycosids dig a shallow nest in the ground. The room temperature was not regulated but was recorded with a thermograph. Fruit flies, *Drosophila melanegaster* Meigen, and green-bottle flies, *Phaenicia cuprina* Wiedemann, were given as foods. These females were also fixed in 70% ethanol after the dispersion of their pulli.

All preserved specimens were dehydrated in an ethanol series. After one hour of exposure in air, they were mounted on stubs with Ag-paste (Dotite Paint) and sputter-coated with Au-Pd, then their abdominal hairs were examined with a Hitachi S–550 scanning electron microscope at an accelerating voltage of 10kV.

The adult female lycosids of two other species, *Pardosa astrigera* L. Koch (=*P. T-insignita*: Kishida et al.) and *P. laura* Karsch, which have the knobbed hairs, and an adult female pisaurid, *Dolomedes sulfureus* L. Koch, which has not the knobbed hairs, were prepared and examined with the same procedure as the controls.

The size and shape of tarsal claws of pulli will be important in discussing the role of female abdominal hairs, so those of *P. laura* were also observed.

* The author has entrusted the identification of this lycosid to a taxonomical specialist of Japanese lycosids, Dr. H. Tanaka. He placed this lycosid in the genus *Lycosa* at first, but transferred it into the genus *Arctosa* after his more detailed examination.

RESULTS

1. Abdominal hairs of adult females in *Pardosa astrigera*, *P. laura* and *Dolomedes sulfureus*, and tarsal claws of pulli of *P. laura*.

The lateral views of dorsal abdominal hairs of *P. astrigera* and *P. laura* are shown in Fig. 1 (A and B respectively, ×310). The surface of abdomen in both lycosids was covered with at least two different types of dense hairs, which strongly bent backwards to form numerous "arches" of the substratum. The hair of one type was the knobbed hair with a tip's knob and lateral rows of micro-spines (Fig. 1, A and B, a). The hair of the other type was one with a scale-like pattern instead of the knob and micro-spines—— "a scaled hair" (Fig. 1, A and B, b). This hair adounded only in the anterior half of dorsal abdomen in these lychsids. There was a hair of another type among the preceeding hairs. This hair had micro-spines as the knobbed hair, but had not the tip's knob and was thicker and longer than the knobbed hair (Fig. 1, A and B, c). This hair stood too steeply and sparsely to take part in the formation of the arches of substratum. Much longer hairs standing upright were also found. They are probably the innervated mechanoreceptors, however they are not shown here.

The apparent characters of the knobbed hair differed among the sites of an abdomen in *P. laura* (Fig. 1, C-E, ×1550). The hairs on the anterior dorsal abdomen were the most typical (Fig. 1, C, a), but the hairs surrounding the epigynum were more or less wavy (Fig. 1, D) and those near the spinnerets were not bent but stood erect considerably (Fig. 1, E). Fig. 1 (C, b) shows a scaled hair clearly.

The shape of tarsal claws of the pulli of *P. laura* did not show any peculiar characters (Fig. 1, F, the inside view in the fourth leg, ×1550).

The lateral view of dorsal abdominal hairs in a female of *D. sulfureus* resembled that of the above two lycosids (Fig. 1, G, ×310; H, ×1550). There were seen the numerous archeus of substratum including scaled hairs. The hairs with a tip's knob were not found.

2. Abdominal hairs of adult females in *Arctosa* lycosids.

Fig. 2 shows the dorsal abdominal hairs of the adult female lycosids of four *Arctosa* species, *Arctosa* sp. (A and B), *A. ebicha* (C and D), *A. subamylacea* (E and F) and *A. depectinata* (G and H). In the lateral views (Fig. 2, B, D, F and H, ×310), the hairs can be classified into at least three types: the hairs that are bent back-wards and have micro-spines (a), the scaled hairs (b) and the hairs that resemble the hairs of the first type but are thicker and longer (c). The hair of

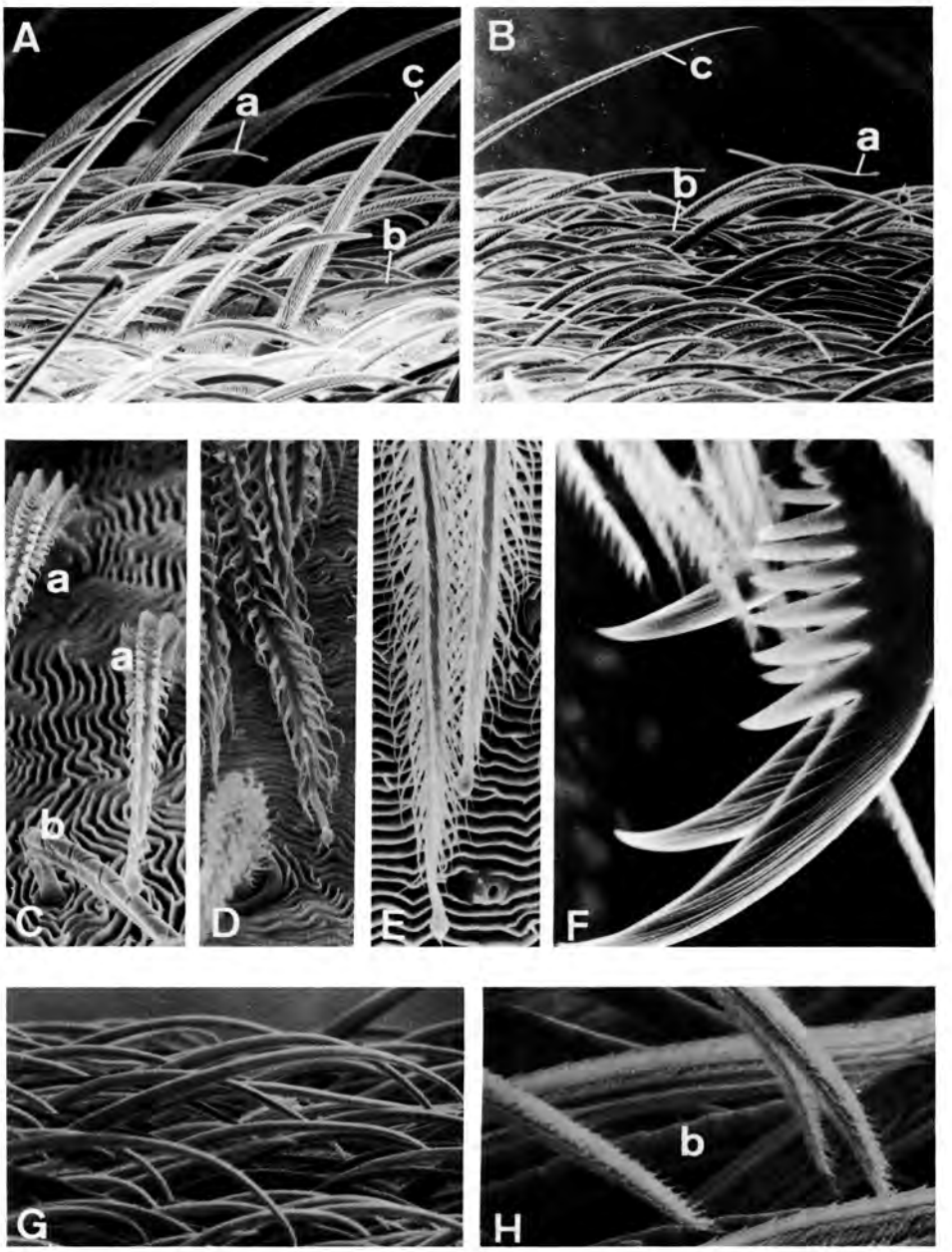

Fig. 1. The specimens observed as controls.

Materials: **A**, *Pardosa astrigera*; **B-F**, *P. laura*; **G-H**, *Dolomedes sulfureus* (Pisauridae).

Sites: **A-C** and **G-H**, dorsal abdomen (lateral view); **D**, near epigynum; **E**, near spinnerets; **F**, claws of the fourth leg of pulli (inside view).

Hair Types: **a**, knobbed hairs; **b**, scaled hairs; **c**, hairs of another type.

Magnifications: **A-B**, ×310; **C-F**, ×1550; **G**, ×310; **H**, ×1550.

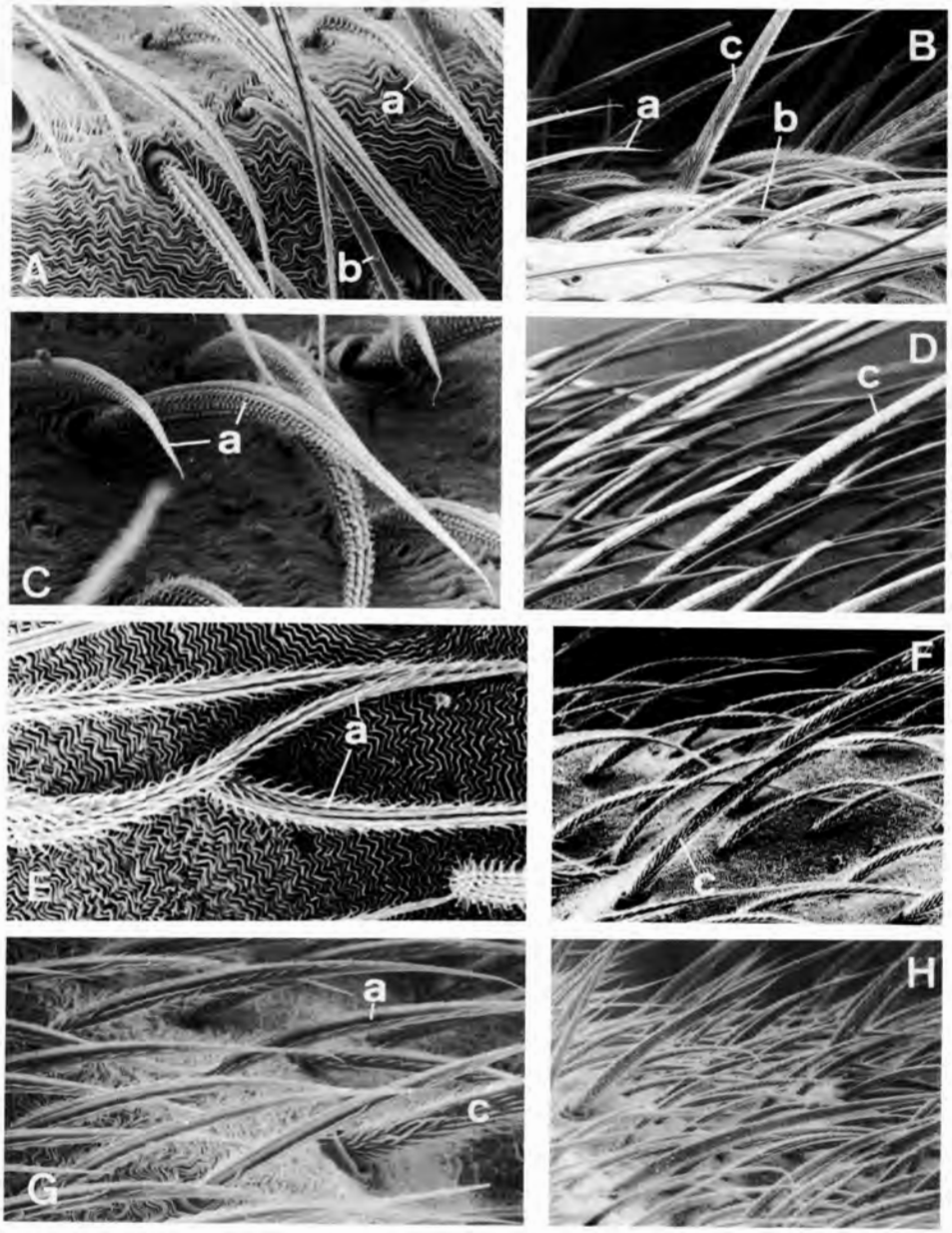

Fig. 2. The dorsal abdominal hairs of *Arctosa* lycosids.

Materials: **A-B,** *Arctosa* sp.; **C-D,** *A. ebicha*; **E-F,** *A. subamylacea*; **G-H,** *A. depectinata*.

Hair Types: **a**, the hairs probably corresponding to knobbed hairs; **b,** scaled hairs; **c,** hairs of another type.

Magnifications: **A, C, E** and **G,** ×780; **B, D, F** and **H,** ×310.

the first type probably corresponds to the knobbed hair in *Pardosa* lycosids, however the knob or its vestige at the tip could not be found even in the magnified views (Fig. 2, A, C, E and G, a, ×700). These species, therefore, resembled rather *D. sulfureus* than *Pardosa* lycosids from the viewpoint of the absence of the knobbed hair.

The scaled hairs of female abdomen were found only in *Arctosa* sp. (Fig. 2, A and B, b).

3. The behaviour of the pulli after emergence from cocoons in *Arctosa subamylacea* and *A. depectinata*.

Both pulli of *A. subamylacea* and *A. depectinata* climbed and settled on their mother's abdomen without any abnormal tendencies.

In *A. subamylacea*, one and nine cohorts of pulli after their emergence were observed in July 1981 and in June-August 1982 respectively. The duration from the beginning of settlement to the ending of dispersion of pulli in each cohort was four days (in four cohorts), five days (in three cohorts) and six days (in three cohorts), and the range of the mean temperature in each case was 27.7–30.9°C, 27.7–31.7°C and 25.9–27.4°C respectively.

In *A. depectinata*, two cohorts of pulli were observed in 1982 (one in July and the other in August). The duration mentioned above was six days in the July cohort and seven days in the August cohort, and the mean temperature in each case was 29.1°C and 30.5°C respectively.

These results did not differ from those in other pulli-carrying lycosids that had been reported by Fujii (1976).

DISCUSSION

None of these *Arctosa* lycosids had the knobbed hairs. The *Pardosa* specimens prepared through the same procedure had the knobbed hairs, so there is little possibility that the tip's knobs of *Arctosa* specimens were removed with the preparation for microscopy. It can be concluded that these *Arctosa* females have no knobbed hairs on their abdomen.

The pulli of *A. subamylacea* and *A. depectinata* climbed and settled normally on their mother's abdomen where no knobbed hairs exist. This result means that the tip's knob of abdominal hair is dispensable both for the pulli's selection of the site to settle and for the continuance of the pulli's settlement on the mother's abdomen at least in these lycosids.

The pulli of *Pardosa* or *Pirata* climb and settle on a substitute mother of different species, but they fail to settle on that of *Arctosa* sp., though this mother

does not refuse them (Fujii, 1980). Perhaps the structure of abdominal hairs of the mother in *Arctosa* sp. (and probably also in *A. ebicha*) is unsuitable for the pulli's clinging itself. The author regards the well-developed arches, which were found almost only in the abdomen of the female lycosid examined here, as the important structure for the pulli's clinging. These arches are formed with the strongly bent hairs of substratum. The pulli seem to cling not to the microspines on a knobbed hair but to the arches of hairs including the smooth scaled hairs with the hooks of tarsal claws, because the size of micro-spines are too small (Fig. 1, C-F). The micro-spines, however, may be more or less useful for the decrease in claws' slipping. The strength of bending and/or the frequency of the arches was less in *Arctosa* sp. and *A. ebicha* (Fig. 2, B and D) than in *A. subamylacea* and *A. depectinata* (Fig. 2, F and H). It has not been examined yet, but is expected that the pulli of *Pardosa* will cling and settle on the abdomen of *A. subamylacea* and *A. depectinata*.

Engelhardt (1964) and Rovner et al. (1973) reported that the lycosid pulli seldom settle on the mother's abdomen covered with a cloth experimentally. In this case, the thickness or other factors of the threads composing the cloth seems to unfit the hooks of the pulli's claw.

The pulli of *Arctosa* sp. and *A. ebicha* do not try to settle on their own mother's abdomen. Even when they are accepted by a *Pardosa* mother, whose abdomen has the proper structure for pulli's clinging, they do not try (Fujii, 1980). This fact shows that the pulli's instinct to cling on some proper structures is the first important factor for the pulli-carrying behaviour in lycosids. The second factor may be the tolerance of the mother in this period to pulli's clinging as Higashi and Rovner (1975) or other authors reported, and the final factor may be the well-developed arches on the female abdomen as the structure for pulli's clinging.

The mutual recognition between the mother and pulli is probably dispensable, because the lycosid mother never ceases to keep contacting with its normal cocoon. The timely cocoon-tearing behaviour of lycosid mother seems to be roughly regulated perhaps by an endocrine system (Engelhardt, 1964; Fujii, 1978 and 1980), and to be precisely regulated by two different (inhibitory and accelerative) motions of pulli in a cocoon. These motions are also considered non-specifically effective (Fujii, 1980).

The significance of tip's knob of female abdominal hair is still obscure. The shape of a tip's knob differs among the lycosid genera (Graefe, 1964; Maeda, 1976), and the tip's knob was not found in the *Arctosa* lycosids in this report. These differences might be merely the phylogenic ones. The taxonomical characters of

Arctosa lycosids have not been established sufficiently, so some *Arctosa* females with knobbed hairs will be also found in the future.

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