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Fossil Insects from the Chôjabaru Formation, Iki Island, Japan*

By

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藤山家徳**：壱岐，長者原層の昆虫化石

Introduction

The occurrence of fossil insects at Chôjabaru, Iki Is. has been reported by KANETAKI (1935), ESAKI (1935) and CHISHAKI (1952). The present article deals with three insect remains excavated in September, 1969 during the investigation by the National Science Museum of Tokyo, together with four other specimens previously collected.

The geology of the Chôjabaru area is summarized in a paper by ISHIDA, FUJIYAMA and others in this Memoir. Fossil insects are found in soft diatom earth, about 17 m thick, intercalated between volcanic conglomerate and scoria, constituting the Chôjabaru Formation. The diatomite is divided into three parts by alternations of sandstone and mudstone, and insect fossils occur in the upper and middle parts. Fossils other than insects from this formation have been studied and are preliminarily reported in this Memoir; land

Fig. 1. Map showing the location of Iki Is.

* Tertiary Insect Fauna of Japan, 4.

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plants by ISHIDA, diatoms by NOGUCHI, fishes by TOMODA. Because this formation is isolated in the small area of eastern Iki, its relation to the other formations cannot be determined directly. As regards the geologic age, the Chôjabaru fossil flora indicates the similarity to the Daijima Flora representing the Middle Miocene flora of Japan. This fact is not contradictory to the stratigraphical and lithological evidences.

Description

ORTHOPTERA

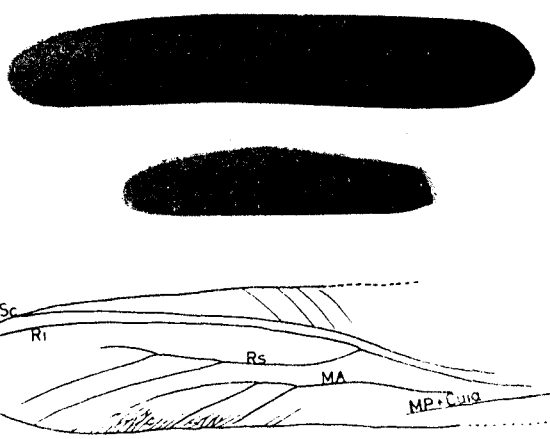
Family Tettigoniidae

Terpandrus? ikiensis sp. nov.

(Plate 15, figs. 1a and 1b; Fig. 2)

Material: Holotype. Complete specimen except for head, antennae and tarsi; unfortunately, partly damaged owing to the intentionally added streaks along the outlines of wings and legs by the collector or somebody else. Stored in the Iki Kyodokan (Museum).

Description: Total length estimated about 72 mm. Vertex and frons missing, hence insertion of antennae unknown. Area of clypeus and labrum rather narrow and elongate. Pronotum appears rather small and short though partly hidden by forewing. Forelegs developed, larger than mid legs; femora strong, about 17 mm long. Front tibiae armed with at least five strong and long spines as long as 3 mm; spines nearly uniform in length; terminal spines on outer side invisible. Auditory organs on front tibiae appear to be covered. Front femora with spines pointing inwards. Middle tibiae and femora armed with spines as in front legs, but a little shorter than those of front legs. Hind legs comparatively long; femora about 32 mm long; spines on posterior tibiae and femora not preserved owing to artificial damages. Posterior femora not much swollen basally. Tarsus of each leg not preserved. Forewing about 58 mm in length, 12.5 mm in breadth, fore and hind margins parallel and not expanding outwards. Sc running parallel with R_1, but not very close to each other; gently undulate. Costal area much broad in basal half. Sc pectinate with



a. Forewing of a tettigonid from Malaysia. ×1.

b. Do of *Tettigonia orientalis* UVAROV from Japan. ×1.

c. Do of *Terpandrus? ikiensis* sp. nov., fossil.

Fig. 2.

several distinct branches towards fore margin. R_1 without branch. Rs arising at 3/8 from base of R, and furcate more than twice. MA branching out more than three times towards hind margin; many veinlets filling between branches. $MP+Cu_{1a}$ straight, much shorter than half of wing-length; Cu complex scarcely preserved. No cross vein, nor marking on wing. Abdomen missing.

Remarks: The present grasshopper apparently belongs to the family Tettigonidae, though the head and antennae are missing. However, the missing tarsi of each leg and antennae obstruct the determination of subfamily and genus. The venation remaining on the fossil forewing is typical of *Tettigonia*-type, which is most typical of modern unspecialized Tettigoniids (ZEUNER, 1939). Comparing with those of recent species, such as *Tettigonia orientalis* UVAROV (Tettigoniinae) from Japan and a species (not Tettigoniinae) from Malaysia, no difference is found between them except that the network is not recognized on the fossil wing. However, according to ZEUNER (1939), the *Tettigonia*-type of venation is found in very many subfamilies, not only in the Tettigoniinae, Decticinae and Saginae, but also in the whole Conocephaloid group of subfamilies.

The present fossil specimen is characteristic in the armature not only on tibiae but on femora with strong spines, which reminds us of a predator like a mantis. The conspicuous spines on legs, the shape, the venation of forewing, etc. seem to indicate the genus *Terpandrus*, a genus of Saginae distributed in Australia. However, both the spines on legs and the wing venation are not decisive characters to diagnose its taxonomic positions (CAUDELL, 1908; ZEUNER, 1939). The proposal of a new extinct genus may be considered. The writer would abandon the strict identification of subfamily and genus on account of the lack of head and tarsi, and temporarily place the species in the genus *Terpandrus*. None of the fossil species hitherto known to science is allied to the present specimen.

HYMENOPTERA

Family Formicidae

Aphaenogaster (Deromyrma) avita sp. nov.

(Plate 15, figs. 2a and 2b; Fig. 3)

Material: Holotype. Winged form, probably female. Found as lying on its back and body turning sideways. Deposited in the Department of Paleontology, National Science Museum, Tokyo, cat. no. NSM-P1-7417.

Description: Rather large in size, total length of body unmeasurable owing to missing abdomen. Head estimated 2.9 mm in length, though not well-preserved. Thorax about 4.8 mm long, much longer than head; antero-dorsal part of thorax rounded in a lateral view. Scutum and pronotum with distinct longitudinally corrugated sculpture. Forewing with venation of *Solenopsis* type, 11 mm long, 4.5 mm broad. Costal cell rather narrow. Stigma comparatively thin. Discoidal cell moderate, rather diamond in shape than trapezoidal. Extension of both upper veins consisting of discoidal cell (parts of M and Rs + M in general

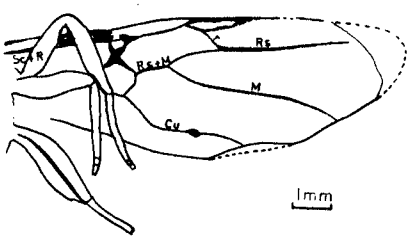


Fig. 3. Forewing of *Sphaenogaster* (*Deromyrma*) *avita* sp. nov.

nomenclature) reaches vein Sc+R. Vein m–cu slightly expanding outwards. Above-mentioned two features, extension of vein and expanding m–cu, may be ascribed to individual variations. The first cubital cell moderately elongate, narrowing in distal half. Cubital vein (vein Rs+M) branches a transverse cubital vein (a part of vein Rs) before middle of 1st cubital cell. The first transverse cubital vein slightly curved upwards. Short transverse vein dividing 1st cubital cell and radial cell (cross vein r) oblique to costal margin of wing. Radial cell open. The second cubital cell open, rather narrow, but expands in distal part owing to descent of cubital vein (vein M). Cubital vein (M) reaches outer margin of wing. Median vein (vein Cu) distinctly bent at about middle. Abdomen missing.

Remarks: Judging from the venation of forewing the fossil ant is closely related to *Deromyrma*, a subgenus of the genus *Aphaenogaster*. *Deromyrma* is distinguished from the other subgenera by a single cubital cell resulting from the reduction of a transverse cubital vein (a cross vein rs–m). However, the same pattern of wing venation appears in the genus *Solenopsis* and the common features between them are represented by a single cubital cell and by the branching of cubital vein at the middle of cubital cell. They are so allied that they are hardly distinguishable unless other features than wing venation, such as antennae, etc., are compared. Consequently, the taxonomic position of the fossil ant would be not fixed, but the writer is inclined to refer it to *Deromyrma*, because of the slightly upward-curved 1st transverse cubital vein (a part of vein Rs), the sculptured thorax and the long head. The first feature suggests the reduction of the 2nd transverse cubital vein. Most of living *Solenopsis* are not sculptured on thorax and head. The long head is characteristic to *Aphaenogaster*.

Eleven fossil species of *Aphaenogaster* have been described so far, viz., four species from the Baltic Amber (MAYR, 1868; WHEELER, 1914), two from the Miocene Radoboj Beds (HEER, 1849, 1867), two from the Miocene Florissant Shales (CARPENTER, 1930), two from the French Oligocene (THÉOBALD, 1937) and one from the Austrian Pliocene (BACHMAYER, 1960). Of these, three species from the Baltic Amber are worker castes, and among the remaining winged forms only three species, *A. berendti* MAYR from the Baltic Amber, *A. maculata* THÉOBALD from Aix-en-Province of France and *A. pannonicus* BACHMAYER from Brunn-Vösendorf near Wien, Austria, show the wing venation like the Japanese fossil ant, while others possess two transverse cubital veins and two cubital cells. BACHMAYER (1960), for comparison, illustrated some fossil wings with venation of only one cubital cell. They had been described as species of "*Myrmica*". Their wing venational pattern

is somewhat allied to the Japanese, French and Austrian fossils, despite that a few of them are possibly *Solenopsis*. With the large size, the wing venation and the sculpture on thorax the Japanese species is easily distinguished from the European species, although comparison of their head or abdomen is impossible.

At the present time, *Aphaenogaster* is widely distributed over the world, predominating in Central America and in the Mediterranean region. According to EMERY (1922) and WHEELER (1922) the subgenus *Deromyrma* is found in the Old World tropics. In the arrangement of subgenera of *Aphaenogaster*, however, some problems remain unsolved (CREIGHTON, 1950).

Several species of *Aphaenogaster* living in main islands of Japan are not placed in the subgenus *Deromyrma* but *Aphaenogaster* s.s. (=*Attomyrma*). More than eight species of *Deromyrma* are known from the Southern Asia south of Taiwan (Formosa) (CHAPMAN and CAPCO, 1951), but the species corresponding to the Japanese fossil would not be found among them.

Family Apidae

"**Apis**" sp.

(Plate 15, fig. 3)

A large fossil bee (NSM-P1-7418), about 18 mm long, was excavated. There is no room for doubt that this is a species of honey bee judging from its wing venation, and is a queen as indicated by abdominal segments, tibiae and tarsi. This fossil honey bee does not fall under the genus *Megapis* or *Micrapis* of ASHMEAD advocated by MAA (1953), but is possibly *Apis* in the strict sense based on the abdominal terga and short wing. It is regrettable that the description is not given here because of the want of the requisite literature to refer to, viz. papers by ARMBRÜSTER, STATZ and ZEUNER.

DIPTERA

Family Bibionidae

Plecia kanetakii sp. nov.

(Plate 15, figs, 4a and 4b; Fig. 4)

Bibio sp. ESAKI, 1935, Kagaku, 5 (2), p. 54, figs. 1, 2.

Material: Holotype. A female specimen, well-preserved except for head. Deposited in the Department of Geology and Mineralogy of Kyoto University, cat. no. JC 1200027. Collected by D. KANETAKI in 1910. Previously illustrated by KANETAKI (1935), ESAKI (1935), and MASUTOMI and HAMADA (1966).

Description: Female. Body rather slender; blackish; total length 12 mm. Head poorly preserved. Antennae short, 0.8 mm long; consisting of more than 11, perhaps 12

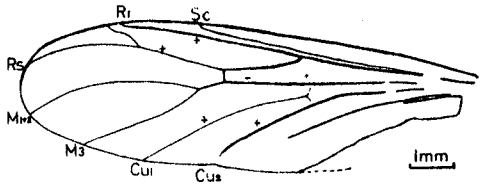


Fig. 4. Forewing of *Plecia kanetakii* sp. nov.

joints; each joint flattened except basal and last ones. Thorax invisible as the specimen lies on its back. Legs slender, not swollen; unarmed with any spines other than numerous short hairs on the whole surface. Anterior femora about 3.1 mm long; anterior tibiae 3.2 mm long, apically without spurs or teeth. Posterior femora 3.7 mm long, tibiae about 3.5 mm. Wings slender, a little over beyond apex of abdomen in repose; 9.6 mm long, 2.8 mm broad. Costal vein reaches apex of wing, with short hairs on first half. First vein (Sc*) thin, ending beyond middle of costal margin of wing. Second vein (R) stout, straight, branching Rs before middle. Stigma absent. Third vein (Rs) branching off forward at about middle; branch rather thin and ending near terminus of second vein. Fourth vein (M) straight in first half, bifurcate in latter half. Third and fourth veins connected by anterior cross vein (r–m). Distance between fork of fourth vein and anterior cross vein about twice the length of cross vein. Fifth vein (Cu_1) not distinct at basal part, but joined with fourth and sixth veins by faint short veins. Distance between two cross veins more than four times the length of cross vein r–m. Abdomen rather slender; with long hairs on hind margin of last segment; no hair on lateral margins of each segment.

Remarks: *Plecia kanetakii* sp. nov. is characteristic in large size, slender wing and large distance between anterior and posterior cross veins. A great number of species of *Plecia* have been recorded from the European Tertiary (HEER, 1849; HEYDEN & HEYDEN, 1865; OUSTALET, 1870; FÖRSTER, 1891; THÉOBALD, 1937; STATZ, 1943; and the others) and American Tertiary (SCUDDER, 1890; COCKERELL, 1911; MELANDER, 1949). It would be difficult to find species corresponding to the present specimen among them, partly for the inaccurateness of the figures in the former reports.

The geographical range of *Plecia* in the present time is world-wide, but its predominance appears in the Oriental and Palaearctic regions, whereas in Africa and South America they are rather scarce.

Bibio? sp.

(Plate 15, fig. 5)

A dipterous specimen (NSM–P1–7419), found by the writer in 1965, is impossible to identify definitely its taxonomic position because of the invisibility of available features, viz. the wing venation, head, etc. However, its form and swollen femora of each leg suggest a species of *Bibio*, though uncertain. The length is 13 mm.

* Nomenclature of wing venation follows LANDROCK (1940) tentatively.

Family Mycetophilidae

Gen. et sp. indet.

(Plate 15, figs. 6a, 6b, 7a and 7b; Figs. 5a and b)

Two specimens of fungus gnat (one is kept at the National Science Museum, Tokyo, NSM-P1-7420, and the other at the Yawata Primary School), probably belonging to the same species, are presented. They are large in size for Mycetophilid gnat. The wings, 12.5 mm and 13.5 mm long, both being 5 mm broad, have characteristic venation. The fossil wing appears to want the cross vein r-m; as a consequence, the radial sector branches from the radius at a low angle. The subcosta is not observed probably owing to its shortness. The media furcates slightly beyond the middle of wing. The cubitus furcates once rather

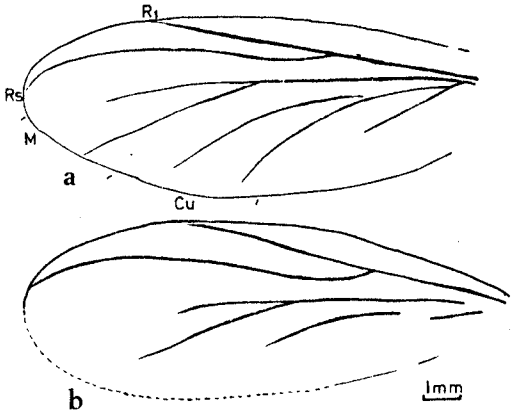


Fig. 5. Forewings of Mycetophilidae gen. et sp. indet.
a. Specimen at Nat. Sci. Mus. Tokyo.
b. Do at Yawata Primary School.

near its base. Such peculiar feature as the reduction of the cross vein r-m, is not found in any living and Tertiary species so far as the writer's knowledge is concerned. They remind us a species of Plecommidae from the Russian Jurassic (RODENDORF, 1964). However, the present Japanese species seems to show rather simplified wing venation than the primitive one. These large fungus gnats may represent a new genus. But preservation of the specimens is too poor to define a genus, the description might be given later when much better-preserved specimens are found.

A Brief Note on the Fossil Insect Fauna of Iki

Besides the above-dealt six species, the occurrence of a species of Orthoptera has been recorded by CHISHAKI (1952), who noted that this Tettigid was identified by ESAKI as a much larger grouse locust than any kindred species distributed in tropical regions. This specimen, unfortunately, has been lost.

It should be impossible to find directly relative species to the fossils from Iki among the

Recent insect fauna of Japan, to say nothing of the corresponding species. All fossil species are of the large type for the respective groups, and a few of the groups are not distributed in Japan or northern Asia, but are found in southern Asia south of Taiwan. The fossil fauna of Iki seems to be rather of warm climate, which coincides with the indication of the Middle Miocene fossil flora in Japan, viz. the Daijima Flora. Most of relatives of the fossils may be detected in the fauna of Taiwan, South and West China and Himalayan District.

要　　約

壱岐芦辺町八幡の長者原海岸の珪藻土層中から産出する木の葉および魚化石は，古くからよく知られているが，昆虫化石はこれにくらべるとはるかに少なく，わずかに4標本が報じられていたにすぎない．金滝大八郎（1935）は，明治42年～大正2年の在島中に昆虫化石3個を発見，うち1個が故江崎悌三博士により，ケバエの1新種の雌と同定されたことを報じている．同年江崎自身もこれにつき簡単な報告をし，*Bibio* sp. としている．この標本は現在も京都大学地質学鉱物学教室に保管されており，本報文で *Plecia kanetakii* sp. nov. として記載したものである．他の1個は大震災で焼失，1個は所在不明である．樗木昇一（1952）は壱岐の化石の報文中で，林徳衛採集の昆虫化石を報じ，これも江崎の鑑定によりヒシバッタ科の1新種で，熱帯産のある属のものに似るが，それよりはるかに大型であるとしている．同氏はこの他に双翅類化石1個を得ているが，惜しいことに両者とも目下所在が明らかでない．

本報文で取扱った標本は，1969年国立科学博物館の行なった対馬および壱岐の総合研究による発掘の際に得られた3標本，壱岐郷土館および八幡小学校に保管の各1個，1965年藤山採集の1個体，それに前記京都大学所蔵標本の計7標本，6種である．

1. *Terpandrus? ikiensis* FUJIYAMA, sp. nov.（キリギリス科テルパンドルス属？）体長 72 mm に達する大型のキリギリス類で，前脚の脛節に鋭いとげのある点，およびその翅脈はわが国のササキリに似ている．しかし化石では，このとげが前脚の腿節，中脚の腿，脛節にもあり獰猛な性質であったことを物語っている．この点は Saginae 亜科であることを思わせ，形や翅脈も現在オーストラリアに分布する *Terpandrus* とひどい違いがないので，ここでは仮にこの属に所属させておいた．しかし，ササキリ型の翅脈および脛節のとげは，分類上の位置を異にするいくつかのグループに見られ，これだけで属をきめられるほど決定的な性質ではない．おそらく，この化石は新属を代表するものと思うが亜科や属の識別に役立つ頭部および跗節が保存されれていないので，新属の設定はさしひかえた．（郷ノ浦町壱岐郷土館所蔵）．

2. *Aphaenogaster* (*Deromyrma*) *avita* FUJIYAMA, sp. nov.（アリ科アシナガアリ属）翅長 11 mm. おそらく♀の羽蟻．翅脈から判断して，アシナガアリ属の *Deromyrma* 亜属のものと思われる．この属の他の亜属のものは，第2肘室があるが，この亜属では第2肘横脈が消失したため肘室が1つしかない．同様な翅脈をもつものに *Solenopsis* トフシアリ属があり，触角さえあれば識別が容易であるが，化石では保存されていない．トフシアリ類には，この化石のように胸部にしわ状の彫刻のあるものがほとんどないこと，翅脈の形状などから *Deromyrma* 亜属のものと判断した．

3. "*Apis*" sp.（ミツバチ科ミツバチ属）翅脈からみて明らかにミツバチの1種で，腹節や脚から女王と推定される．東南アジアに分布する大型の *Megapis* でないことはたしかだが，化石ミツバチの文献が不足なので属種の決定は後日にまちたい．

4. *Plecia kanetakii* FUJIYAMA, sp. nov.（ケバエ科アシボソケバエ属）頭部を除いて保存良好な標本で，翅脈から *Plecia* 属と判断される．Rs から前方に小さな枝がでて，前縁に終っている．Cu_1 の基部は明瞭でないが，短い横脈で前後の縦脈に連なるようである．この横脈と，Rs と M をむすぶ前方の横脈との間隔の大きいことが，本種の特徴といえよう．触角は短かく，脚は腿節も太くなく，とげも見られない．（京都大学地質学鉱物学教室所蔵）．

5. *Bibio*? sp.（ケバエ科ケバエ属？）標本は背面を下にしており，翅脈が観察できないので属を決定することがむずかしい．しかし，大きさ，全形，ふくらんだ腿節などから *Bibio* の可能性が強い．

6. Mycetophilidae, gen. et sp. indet.（キノコバエ科属種未定）恐らくキノコバエ科に属すると思われる2標本．翅長がそれぞれ 12.5 mm および 13.5 mm と，キノコバエとしては甚だ大きい．翅脈は R と M をむすぶ横脈 r-m を欠き，Rs は低角度で R_1 から分岐している．このような r-m をもたないキノコバエは現生，化石とも見当らず，新属を代表するものと考えられる．しかし標本の保存は良好でなく，将来同種がさらに発見される可能性もあるので，後日改めて記載することにした．横脈 r-m の欠除は，原始的な形態を残していると考えるより，r-m の退化したものと解した方がよいであろう．

以上6種中，*Deromyrma* 亜属は東洋熱帯に分布の中心があり，台湾まで見出される．*Plecia* 属は世界中に分布し，日本にも小型種が数種産するが，むしろ熱帯に多い．キリギリス科のものは，現在，ヨーロッパ，アフリカ南部，オーストラリアと隔たれた3地域に分布する Saginae 亜科のものらしいが，標本が不完全で決定的ではない．一般に，長者原層より産出の昆虫化石は，その所属するグループのものとくらべると大型であることが特徴である．また本層の化石は，現在の日本の昆虫相に，その類縁を見出すことはできず，むしろ台湾，中国南・西部などの東洋熱帯の地域で期待できそうである．

最後に，長者原産昆虫化石を研究するに当り，発掘を快く許可された地主の貞方勝則氏，長者原珪藻土層の共同研究者，京都大学石田志朗助教授，発掘あるいは標本貸与に御便宜と御協力をいただいた初山小学校長森村正氏，壱岐郷土館長西川福雄氏，石田村公民館長林徳衛氏，元八幡小学校長久田琢磨氏，現八幡小学校長中田正大氏，田河中学校長吉木豊氏，その他現地の関係諸氏に厚く御礼申し上げる．また現生および化石昆虫につき種々御教示を賜った，松下進京都大学名誉教授，国立科学博物館黒沢良彦氏，同石川良輔氏，農業技術研究所長谷川仁氏，同福原檜男氏，相洋高等学校久保田政雄氏，埼玉大学山崎柄根氏，高知理科教育センター岡本啓氏，福岡城南高等学校長桾木昇一氏に感謝の意を表する次第である．

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Explanation of Plate 15

Fig. 1. *Terpandrus? ikiensis* sp. nov. Holotype, stored in the Iki Kyodokan (Museum). a, ×1. b, ×1.5.

Fig. 2. *Aphaenogaster* (*Deromyrma*) *avita* sp. nov. Holotype, NSM-P1-7417. a, ×1. b, ×2.

Fig. 3. "*Apis*" sp. NSM-P1-7418. ×1.

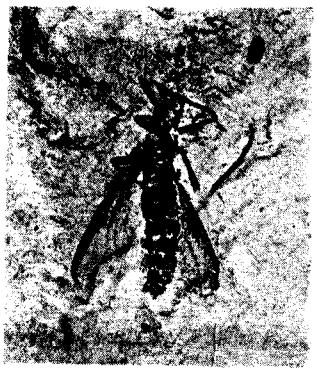
Fig. 4. *Plecia kanetakii* sp. nov. Holotype, stored in the Kyoto Univ., JC1200027. a, ×1. b, ×2.

Fig. 5. *Bibio?* sp. NSM-P1-7419. ×1.

Fig. 6. Mycetophilidae, gen. et sp. indet. Stored in the Yawata Primary School. a, ×1. b, ×2.

Fig. 7. Mycetophilidae, gen. et sp. indet. NSM-P1-7420. a, ×1. b, ×2.

1a

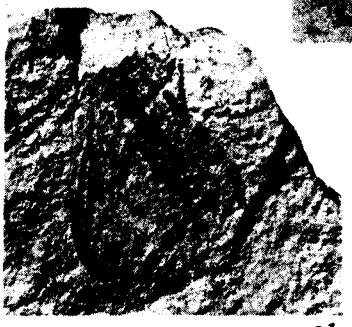


4b

1b

4a

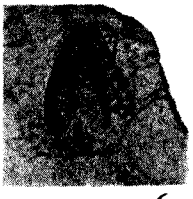
3



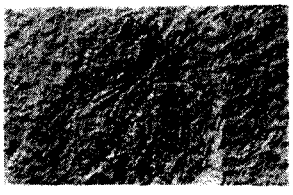
6b

2a

5



6a



7a

2b

7b