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Some Late Cenozoic Cicadas from Japan

By

Ienori FUJIYAMA

Department of Paleontology, National Science Museum, Tokyo 160

Introduction

Four Cenozoic fossil cicadas have hitherto been known in Japan: *Meimuna protopalifera* FUJIYAMA from the Lower Miocene of Nasu, *Terpnosia nigricosta* (MOTSCHULSKY) from the Pleistocene of Shiobara (FUJIYAMA, 1969) and *Tibicen* sp. aff. *japonicus* (KATO) and *Terpnosia* sp. aff. *vacua* (OLIVIER) from the Lowermost Miocene or Upper Pliocene of Tatsumi-tôge (KINUGASA and MIYATAKE, 1976, 1979). The species described here make an addition to these records.

The nomenclature of wing venation based on its genesis by COMSTOCK and NEEDHAM is adopted in this paper, which has been supported by later specialists (*e.g.* MAYERS, 1928) though opinions are varied on the nomenclature.

The author expresses his deep thanks to Dr. Yûshirô IWAO of Saga University, Mr. Kazuhiko UEMURA of our museum and Messrs. Nobukichi and Nobuo KATO of the Shiobara Fossil Plant Garden for offering these materials. He is also indebted to Dr. Yoshihiko KUROSAWA of our museum, Dr. Masami HAYASHI of Saitama University and Mr. Kan'ya NARUSE of Ichikawa for their kind advice and offer of the specimens for comparison with the fossils.

Geology, Ages, associated Floras and Paleoclimate

(1) Kazusa, Nagasaki Prefecture

In the southern part of the Shimabara Peninsula, the Late Cenozoic Kuchinotsu Group, underlying the ejecta of Mt. Unzen and other volcanoes is widely exposed. OTSUKA (1966) proposed the sequence of the Kuchinotsu Group as follows: the group unconformably overlying the Paleogene basement rocks is divided into the Ôya, the Kazusa and the Kitaarima Formations in ascending order. Afterwards, he retracted the Kazusa Formation to correlate it with the uppermost part of the Ôya Formation (OTSUKA, 1971). The Kitaarima Formation is mostly of marine origin, and the Ôya Formation bears some plant beds at different horizons and a rich mammalian fauna.

The floras in the upper and lower parts of the Ôya Formation were studied by TAKAHASHI (1954): *Carpinus carpinoides* MAKINO, *Fagus crenata* BLUME, *Zelkova ungeri* KOLVATS, *Buxus japonica* MUELL and *Smilax china* LINNÉ are dominant at the upper horizon from which fossil insects were yielded. Considering the luxuriance

of *Thuja standichii* CARR. *Fagus crenata*, *Buxus japonica*, etc., he concluded that the temperature was 4–5° lower than the present, which was supported by the pollen analysis by OTSUKA (1966). Even supposing these species indicating a cold climate were derived from surrounding highlands, the climate should have never warmer than the present and might have been mild.

The flora in the Ôya Formation is characteristic in containing some exotic plants such as *Liquidambar, Glyptostrobus*, *Metasequoia*, etc., which may be relics of Tertiary-type plants showing a warm and humid climate, but they are less in number than indicators of temperate climate.

Fossil insects have been found in the whitish tuff of the upper part of the Ôya Formation at Kashiyama. Two fossil wings of dragonfly and damselfly from the fossil site are identified to the living species, *Oligoaeschna pryeri* MARTIN and *Calopteryx atrata* SELYS (ESAKI and ASAHINA, 1957). According to them, *Oligoaeschna* is one of the most primitive genera of Aeshnidae and is widely distributed throughout tropical Southeast Asia. *O. pryeri*, endemic to Japan, is the species which invaded most northwards and is seen from Hokkaido to Yaku Island. *Calopteryx atrata* is a common species not only in Japan (Honshû-Kyûshû and Yaku Island) but also in Korea and China (south of Northeast Province).

The hindwing of cicada presented in this paper was found at the same locality of Kashiyama; some other fossil materials from the site, a hindwing of dragonfly, a larva of psephenid beetle and a leaf-hopper, are in the author's hand.

The Tsubami vertebrate fauna is composed mostly of Villafranchian-type fossil deer; *Cervus* (*Rusa*) *kyushuensis* OTSUKA, *C.* (*Axis*) *japonicus* OTSUKA and *C.* (*Deperetia*) *shimabarensis* OTSUKA (OTSUKA, 1967). In the flora associated with the Tsubami fauna the temperate species are conspicuous, indicating the first cold climate stage in the age of Kuchinotsu Group (OTSUKA, 1971).

Recently, OTSUKA (1979) obtained some chronological data on the Kuchinotsu Group by the fission track method. The tuff including fossil insects, probably corresponding to Tuff IX, is between Tuff VII (1.76±0.22 m.y.) and Tuff XIII (1.43±0.27 m.y.), consequently the bed is approximately attributed to Early Pleistocene.

(2) Kuwanomaru, Yoshida, Kagoshima Prefecture

The greater part of the northwestern district of Kagoshima Prefecture is covered with volcanic layers of younger ages. Intercalated between them, clastic sediments are sporadically exposed at various horizons, of which the Yoshida plant bed probably belongs to the uppermost horizon.

According to ENDO (1939) the Yoshida fossil flora is characteristic in consisting of a small number of species in spite of a great number of fossil leaves; only seven species of leaf fossil were identified. He pointed out a common feature between the diatom floras of Yoshida and Shiobara, and stated that the Yoshida flora should be Pleistocene in age, not Tertiary, judging from the components of the flora.

ONOE (1972) recorded fifteen plant species from this bed; *Fagus crenata* BLUME amounts to more than 50% in quantity which suggest the existence of pure beech forests

Fig. 1. Showing the localities of fossil cicadas and distributions of living species of *Graptopsaltria* and *Tanna*.

not far from the fossil site at that time. *Quercus glauca* THUNB. and *Zelkova serrata* MAKINO come next. The bed contains no exotic nor extinct species. At the present time, *Fagus crenata* grows at the altitude of above 1000 m in the mountains of Kyûshû, so a somewhat colder climate should be inferred for the Yoshida flora. ONOE has tentatively assigned the flora's age to Early Pleistocene.

The fossil floras in the Late Cenozoic strata of the area north of Kagoshima City were studied again by TAKAYAMA and HAYASAKA (1974). They classified the plant-bearing strata in the area into three different formations mainly by the lithostratigraphy and the floral character: Lower formation of the older sedimentary group, Upper formation of the older sedimentary group, and younger sedimentary formation. The flora of Yoshida belongs to the last one. They considered that the fossil materials collected by them from Yoshida showa rather warm climate; at a fossil site the

species of *Zelkova* and *Quercus* are dominant, in another locality many species of Lauraceae are found. They concluded the habitat was a coastal plain and lowland forest of broad-leaved trees in the warm forest zone, neighbouring the mountainous hinterland with a cooltemperate forest of the needle-leaved trees.

A rhinoceros tooth was found at the extension of the Yoshida clay bed (SHIKAMA, 1967). This species was thought to be assignable to *Rinoceros sinensis* OWEN which was known from Szechwan (Villafranchian) of North China, but it is somewhat allied to *R. mercki* JAGER from Choukuotien (Günz-Mindelian).

YABE (1946, 1955) considered the age of the Yoshida-mura shell bed to correspond to the first interglacial epoch, in comparison with the Ryûkyû Limestone and other formations, faunas and floras. Consequently, the age of Yoshida plant bed underlying the Yoshida-mura shell bed may be assigned to the first glacial epoch.

Putting all accounts together, the age of the bed should be referred to Early to Middle Pleistocene. If we attach importance to the absence of exotic plants, *e.g. Metasequoia, Liquidambar*, etc., the age must go up above the Lower Pleistocene, probably corresponding to Middle Pleistocene, and it is younger than Kazusa.

No other fossil insects than the present material have been found yet from the Yoshida plant bed.

(3) Shiobara, Tochigi Prefecture.

Shiobara has been well-known as a fossil locality of not only plants but also insects. The lacustrine Shiobara Group that filled the valley of the Hoki-gawa, is exposed extending 5.5 km along the valley.

Stratigraphical evidence for age determination is scanty, but referring to the floral content, topography, etc., the Shiobara Group is obviously assigned to an age later than Middle Pleistocene. Recently, it was reported that the data by radio-carbon method showed much younger ages than hitherto considered, about 33,000 years B.P. (YAMAZAKI, 1975). However, the present author has attained a result pointing an age older than 37,800 years in the re-examination by the same method. He would make reference to the dating of the group on another occasion.

Descriptions of Fossil Cicadas

Genus *Graptopsaltria* STÅL, 1886

Graptopsaltria aff. *nigrofuscata* (MOTSCHULSKY)*

Japanese name "Abura-zemi"

Figs. 2, 3A

Fossil specimen examined: An almost complete left forewing showing undersurface in whitish diatomaceous mudstone. NSM-PA12018, stored at the National

* NARUSE (1971) pointed out that *Fidicina nigrofuscata* was named by MOTSCHULSKY in 1866, and it appeared in the bulletin wanting an exact date of publication other than 1866, so he asserted that *Graptopsaltria colorata* STÅL proposed for the same species in July 1866, is valid. However, the familiar name *nigrofuscata* is adopted here.

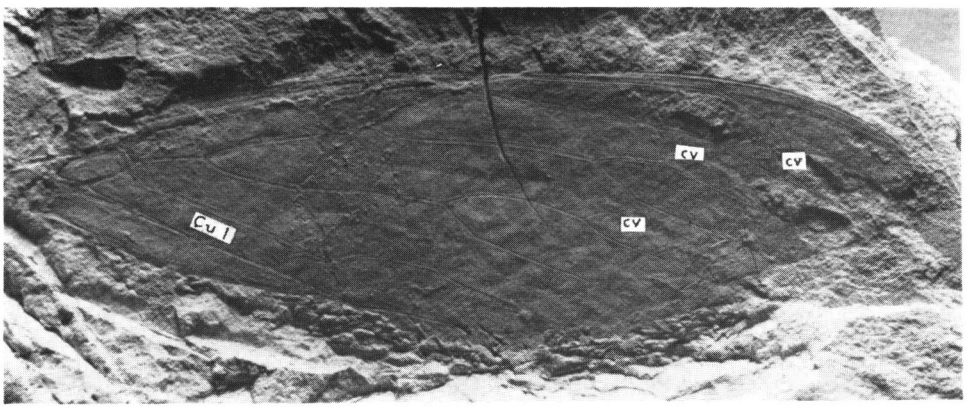

Fig. 2. *Graptopsaltria* aff. *nigrofuscata*. Yoshida, Kagoshima Pref., Japan. Middle Pleistocene. NSM-PA12018, ×2.5.

Science Museum, Tokyo. Found at Kuwanomaru, Yoshida-machi, Kagoshima Prefecture by Kazuhiko UEMURA, from the Yoshida plant bed, which is referred to Middle Pleistocene in age.

Comparison and remarks: The remaining part is about 45.0 mm long, 14.1 mm wide. Estimated total length is 47.1 mm, width is 14.9 mm.

Graptopsaltria nigrofuscata is the commonest and a representative cicada of Japan. It is distinguishable not only by its opaque brownish wings but also by its wing venation. First cross vein (r_3–r_{4+5}) of forewing slants inward and is arched toward its apex, not inclined outward and straight as in other species of Japanese cicadas. The thin and long first cubital cell (last ulnar area of DISTANT (1906)) of forewing is also characteristic in this genus, and consequently the forewing with a broad hind margin looks rather sub-triangular than fusiformed.

The present fossil almost corresponds to *Graptopsaltria nigrofuscata* in the abovementioned venational manner and other features, although the fossil wing is narrower than the living specimens, consequently the cells in the wing are thinner. Measuring 21 specimens, the author obtained the ratios 2.89–3.10 (mean value 2.96) of length to width of forewing of *nigrofuscata,* whereas the fossil wing shows about 3.20 which is far beyond the range of *nigrofuscata* so far as examined. It is noticeable that the veins of the fossil are more delicate than living individuals.

Graptopsaltria nigrofuscata is distributed in Japan (Hokkaido-Kyûshû), Korea and North and Central China. In the Southwest Islands of Japan, this species is found only in Yaku Island. The species in the islands south of Amami-ôshima was distinguished from *nigrofuscata* as another species *G. bimaculata* by KATO (1925), and this opinion has been accepted in the succeeding studies (*e.g.* ISHIHARA, 1961, 1968). Differences in coloration, form of pronotum, markings and sound between these closely related species have been mentioned by the previous authors, but little has been referred to the features on wings.

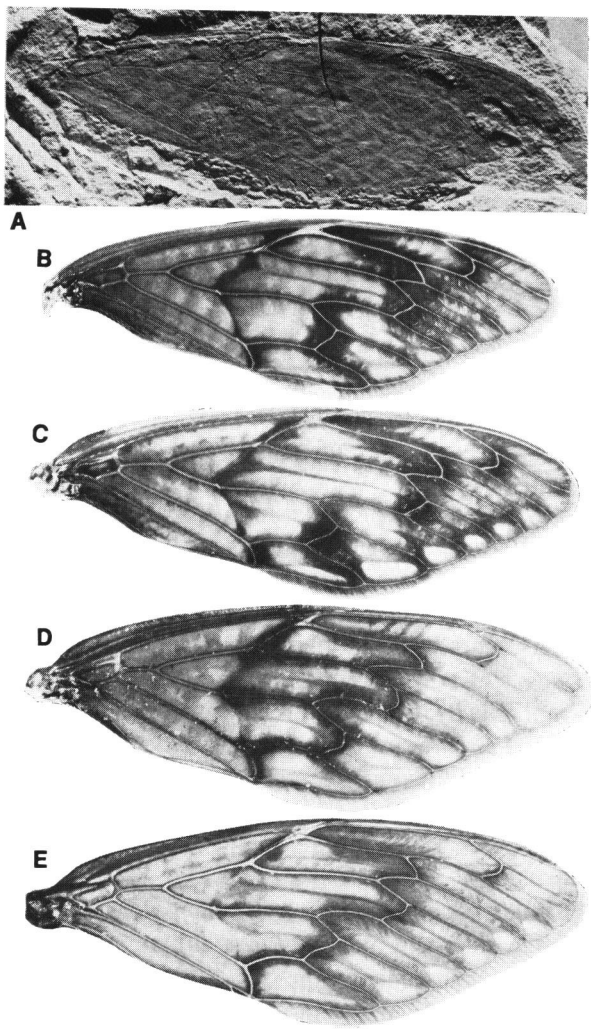

Fig. 3. A. *Graptopsaltria* aff. *nigrofuscata*, fossil, Yoshida, NSM-PA12018.
B. *Graptopsaltria nigrofuscata*, Honshû, Japan.
C. ditto.
D. *Graptopsaltria bimaculata*, Amami-ôshima Island.
E. *Graptopsaltria bimaculata*, Okinawa Island. ×1.5

KATO (1961) pointed out that the forewing of *bimaculata* is shorter than *nigrofuscata*. According to the present author's measurements of eleven materials, the ratios are 2.70–2.86 (mean value 2.79) except for an unusual individual with long wings whose ratio is 2.99. Within the species *bimaculata*, the individuals from Amami-ôshima seem to have somewhat longer wings (mean value 2.83) than those from the

Okinawa Islands (mean value 2.78). The materials from Amami-ôshima show a tendency that the third (m_2–m_3) and fourth (m_4–cu_{1a}) cross veins are distally arched, although these slight differences cannot be considered definite on account of a small number of materials. Judging from the wing form, the fossil seems to be more distant from *bimaculata* than from *nigrofuscata*.

Graptopsaltria comprises another species from West China, *G. tientia* KARSCH, of which forewing seems moderately elongate (with the ratio 3.00 or so) according to the illustration by DISTANT (1912) and the photograph by LIU (KATO, 1956).

It is difficult to decide whether the present fossil represents an unusual individual with long wings of *nigrofuscata* or another species or subspecies, because a single fossil forewing cannot give sufficient information. The author is inclined to the latter case, namely this fossil wing may represent an ancestral species of living *Graptopsaltria* or an occupant before *nigrofuscata* and *bimaculata*. He has no intention of discussing here the phylogenic relation between fossil and living *Graptopsaltria* and the distributional change through geological ages.

Genus *Tibicen* LATREILLE, 1825

Tibicen bihamatus (MOTSCHULSKY)

Japanese name "Ko-ezo-zemi"

Fig. 4A

Fossil specimen examined: An impression of undersurface of right forewing, lacking parts of base and hind margin. Stored at the National Science Museum, Tokyo, NSM-PA12045. Found at Naka-shiobara, Tochigi Prefecture from mudstone of the Shiobara lacustrine bed (Shiobara Group) by Nobuo KATO. Middle or Late Pleistocene.

Comparison and remarks: The present fossil specimen is a right forewing of medium size. The apex is not much protruding and its first apical cell (R_2) is very thin, consequently the vein R_2 terminates anteriorly to wing apex, not at apex or posteriorly. The second apical cell ($2R_3$) expanding toward wing apex, such as in the present fossil, appears only in the species of *Tibicen* and *Cryptotympana* among living cicadas of Japan and its neighbouring areas. The fossil is allied to the species of *Cryptotympana* in the venational manner except thinner cells M, $1M_2$ and $1R_5$, but it may be more reasonably regarded as a small species of *Tibicen* on the ground of shape, length and venation of the wing. *Cryptotympana* bears large, broad and subtriangular forewings. Comparing with a great number of specimens of *Tibicen, Tibicen bihamatus* is reasonably assigned to the present fossil, whose wing venation is within a range of variation of *bihamatus* though venation of *Tibicen* is variable. For example, the stem of M of the fossil is shorter than the pedicel of M_{1+2} (from the diverging point of M to the junction with the proximal cross vein), but the ratio of these veins in this species is variable, the former is shorter or equal, and seldom longer than the latter in individual.

The length of the fossil wing is 39.0 mm, the maximum width of remaining part is

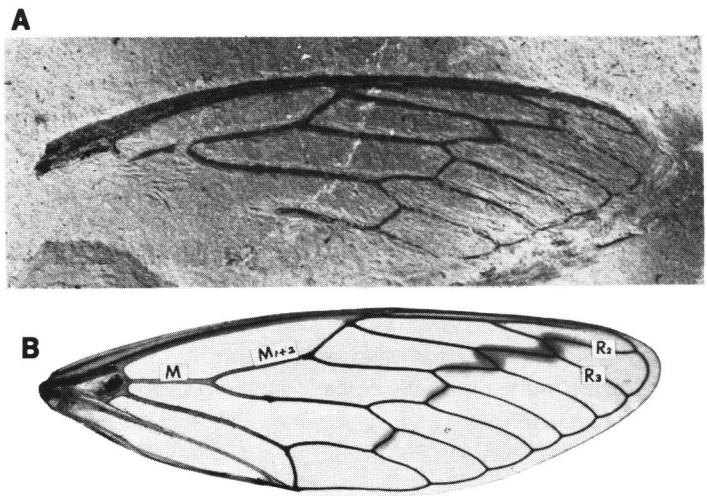

Fig. 4.
A. *Tibicen bihamatus*, fossil, Shiobara, Middle or Late Pleistocene, NSM-PA12045.
B. *Tibicen bihamatus*, Honshû, Japan. ×2

11.7 mm; cosequently the fossil corresponds to a small individual of living *bihamatus*.

Another species of *Tibicen, T. esakii* KATO is known from Japan, which is hardly distinguished from *T. bihamatus* by wing venation alone. *T. esakii* limitedly lives in Yaku Island south of Kyûshû, whereas *T. bihamatus* is widely distributed in the mountain regions in Japan and adjacent areas, from South Sakhalin and the South Kuriles to Shikoku (not in Kyûshû). *Tibicen kyushuensis* (KATO), close to *bihamatus* in size, is distinguishable by its broader wing and thicker veins.

Tibicen bihamatus commonly appears in the *Fagus crenata* zone of the mountainous district of Japan in summer (July-August) succeeding *Terpnosia nigricosta*, which appears in June and July. HASHIMOTO (1966) observed *Tibicen bihamatus* lives at altitudes from about 900 m to above 1250 m in the Nasu Highlands not far from Shiobara. At the present time this cicada is not found at the fossil site (570 m above sea-level), but lives in higher forests surrounding Shiobara. The habitat of this species in the present time and geologic time, is similar to that of *Terpnosia nigricosta*, though the former's habitat seems to be a little higher.

Genus *Terpnosia* DISTANT, 1892
Terpnosia nigricosta (MOTSCHULSKY)
Japanese name "Ezo-haru-zemi"
Figs. 5B, C; 6A, B

Fossil specimens examined: A fossil forewing showing undersurface; of which some veins including fore-marginal vein are broken in accident, perhaps pecked by

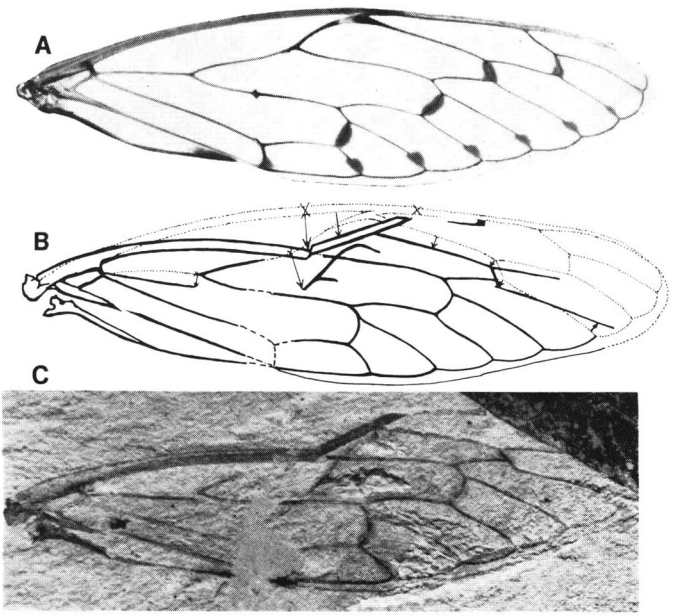

Fig. 5.
A. *Terpnosia nigricosta*, Honshû, Japan.
B. *Terpnosia nigricosta*, fossil (restored).
C. *Terpnosia nigricosta*, fossil, Shiobara, Middle or Lower Pleistocene. NSM-PA12019. ×2.5

a bird. NSM-PA12019. Another specimen represented by head, pronotum and mesonotum with the basal parts of forewings. NSM-PA12020. Both are stored at the National Science Museum, Tokyo, a counterpart of the latter specimen is stored at the Shiobara Fossil Plant Garden. Found at Naka-shiobara, Tochigi Prefecture from the Miyajima Formation of the Shiobara Group by Nobukichi KATO. Middle or Late Pleistocene.

Comparison and remarks: A little broken forewing may be restored as shown in Fig. 5B. The wing, of which the remaining part is 32.4 mm long, is rather elongate fusi-formed, so that every cell, especially the cubital cell, is thin and long. Among medium-sized species of Japanese cicadas, only *Terpnosia nigricosta* has always more than 2.00 ratio of length of cubital cell to that of the 8th apical cell, whereas other species are less than 2.00 (*e.g.* some measurements show 1.30 in *Meimuna opalifera*, 1.40 in *Tanna japonensis*, 1.85 in *Euterpnosia chibensis*, 1.90–1.95 in *Terpnosia vacua*). The ratio of length to width of the fossil wing is 2.18, which corresponds to the maximum value in *Terpnosia nigricosta* (2.11–2.17). Other venational features of the forewing do not prevent it to be identified as *Terpnosia nigricosta*.

Another incomplete specimen from the same locality, represented by head, pronotum, mesonotum and the basal parts of forewings, is measured as follows: estimated

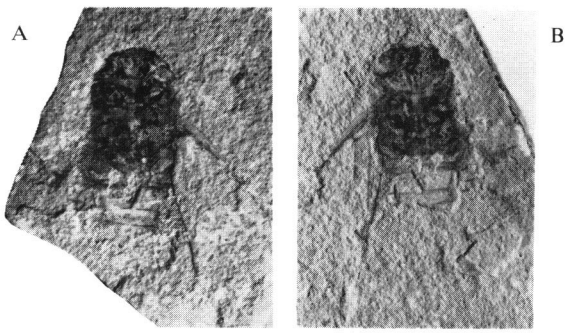

Fig. 6.
A. *Terpnosia nigricosta*(?), fossil, Shiobara, NSM-PA12020.
B. ditto, counterpart. ×1.6

width of head including eyes is 7.2 mm, that at posterior part of pronotum is 9.0 mm, that of mesonotum is 8.2 mm. These values are within the venational range of *T. vacua* or *Euterpnosia chibensis*, though the specimen looks somewhat narrower due to torn marginal parts. Markings on pronotum and mesonotum are not sufficiently preserved to be compared with allied species. It seems to belong to *Terpnosia nigricosta* except that the hind margin of the fossil head is anteriorly slightly more arched, and the central inverted-triangle in inner part of pronotum is a little larger.

Previously the present author (1969) recorded the occurrence of the same species from the same fossil bed and the two specimens described here are an addition to the record. It is interesting that no other species of fossil cicada living in lowlands of Japan at present, have been discovered in spite of years' search by Messrs. KATO of Shiobara Fossil Plant Garden. Living *Terpnosia nigricosta* is never found in the forests around the fossil site of Shiobara (about 570 m above sea-level), whereas we may easily encounter it in the mountain forests hemming the Shiobara Hot Spring. The significance of the occurrence of the species has been mentioned in the previous report (FUJIYAMA, 1969).

Genus *Tanna* DISTANT, 1905

Tanna(?) sp.

Figs. 7, 8A

Fossil specimen examined: An incomplete hind wing lacking its base, apex and anal area. Found in the white tuff of the Early Pleistocene Ôya Formation of the Kuchinotsu Group at Kashiyama, Kazusa-machi, Minami-takaki-gun, Nagasaki Prefecture, by Yûshirô IWAO. Stored at the National Science Museum, Tokyo, reg. no. NSM-PA12017.

Comparison and remarks: The fossil measures 32 mm in maximum length of the remaining part. In size, this fossil species falls under the large-size group in Japan,

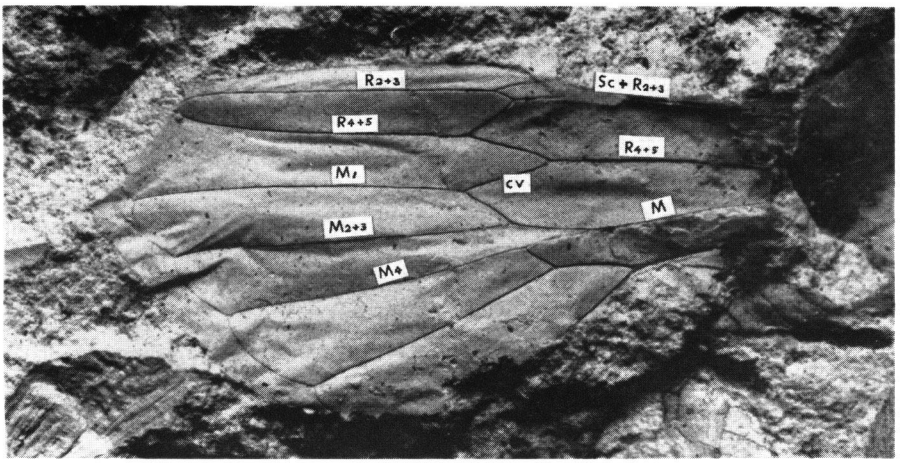

Fig. 7. *Tanna* (?) sp. Kazusa, Nagasaki Pref., Japan. Lowermost Pleistocene. NSM-PA12017. ×4

including *Cryptotympana japonensis* KATO, *Tibicen flammatus* (DISTANT), *T. japonicus* (KATO), *Oncotympana maculaticollis* (MOTSCHULSKY) and *Graptopsaltria nigrofuscata* (MOTSCHULSKY).

Compared with the living species of Japan and its adjacent areas, the following venational features of the fossil wing may be characteristic.

(1) The first apical cell is unusually elongate and the distal half of R_{2+3} is straight, suggesting a long hind wing with a straight foremargin.

(2) In most of cicadas, vein Sc of hind wing coalescens into vein R_{2+3}, and deviates forward from vein R_{2+3} at about its middle (although often indistinct in some species for running against hamulus). After turning back at foremargin it reunites with R_{2+3}, consequently a small trianglar cell is formed near hamulus. When a step is made between the basal and distal halves of R_{2+3} (the basal half is $Sc+R_{2+3}$) owing to breaking at a terminus of cross vein r_{2+3}–r_{4+5}, a small inequilateral square cell is produced instead of a triangular one. In the fossil wing, a fault of vein R_{2+3} at the middle is so remarkable that it does not appear in living species. The square cell of the fossil is unusually elongate and inclined at low angle. However, these venations are considerably variable within a species.

(3) R_{2+3}, R_{4+5}, M_1 and M_{2+3} are subparallel at distal halves, not diverging outwards as in most of living species of Japan.

(4) Four veins forming the basal sides of the first-third apical cells are gently oblique, and they look like the letter W.

The venational features mentioned above are compared with those living species in Japan, as follows:

(1) Straight R_{2+3} does not appear in large-sized species in Japan other than *Tibicen*. But, the species of *Tibicen* (*T. japonicus*, *T. flammatus*, *T. bihamatus*, etc.)

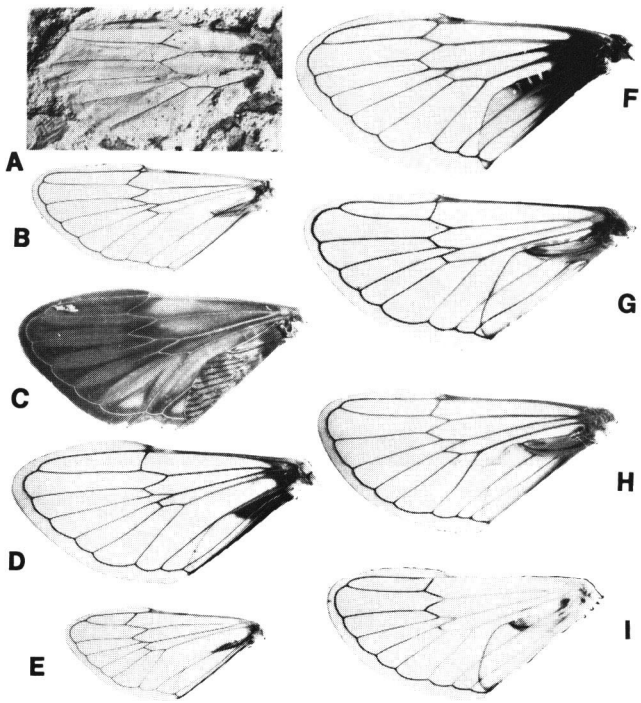

Fig. 8. Hind wings of the fossil and living species. × 1.3
A. *Tanna*(?) sp., fossil, Kazusa. NSM-PA12017.
B. *Tanna japonensis japonensis*, Honshû.
C. *Graptopsaltria nigrofuscata*, Honshû.
D. *Oncotympana maculaticollis*, Honshû.
E. *Meimuna opalifera*, Honshû.
F. *Cryptotympana japonensis*, Honshû.
G. *Tibicen japonicus*, Honshû.
H. *Tibicen flammatus*, Hokkaido.
I. *Tibicen bihamatus*, Honshû.

have less elongate first apical cells and the four veins R_{2+3}, R_{4+5}, M_1, M_{2+3} diverging outward without exception. Such a slender first apical cell as noticed in this fossil is never seen in Japanese cicadas except *Tanna japonensis*, a much smaller species.

(2) A step on R_{2+3} and a small square cell formed by the Sc and R_{2+3}, sometimes appears only in *Cryptotympana japonensis* and *Tanna japonensis*. However, *Cryptotympana japonensis* is obviously distinguished by its R_{2+3} curving down in the distal half and not slender first apical cell. In *Tibicen*, the small cell is variable in shape; triangular, square or even absent. The step on R_{2+3} is inexistent or negligible so far as examined in 58 specimens (*T. japonicus* 49, and *T. flammatus* 9). In the fossil the step and the large cell are remarkable.

In *Tanna japonensis* such as a fault (break) on R_{2+3} and a small square cell caused

by a broken R_{2+3} are found in more than one-third of specimens (14 of 36 individuals in subspecies *japonensis*, 3 of 7 in subspecies *ishigakiana*). In *Pomponia fusca*, which is relative to *Tanna* and distributed in Taiwan and South Ryûkyû (HAYASHI, 1974), there appears a low step in one-fifth of 25 individuals examined.

(3) Japanese living species show the veins R_{2+3}, R_{4+5}, M_1, M_{2+3} more or less diverging, but not remarkably in *Tanna japonensis*.

(4) W-like veins of the fossil hind wing are most closely allied to those of *Graptopsaltria nigrofuscata*, next to *Tanna japonensis*. In *Graptopsaltria nigrofuscata*, veins forming W are variable, generally deeper than in the fossil, and every vein is always slightly curved near both termini. The above-mentioned four longitudinal veins of *Graptopsaltria nigrofuscata* expand outward, and they are farther apart from each other than in the fossil. Its first apical cell differs from that of the fossil in shape. In *Tibicen* these veins are variable, especially in the angle of the cross vein r_{2+3}–r_{4+5} and in the length of the stalk of M_1.

As the result of comparison with the living cicadas in Japan and its adjacent areas, the author can not find a species exactly corresponding to the fossil. The fossil species is out of the range of variation of every living species, even in consideration of the large venational variation in cicada.

Setting aside the size difference, *Tanna japonensis* has features most common to the fossil. However, the difference in size between the two species is so great that they cannot be assigned to a single species. The fossil may represent an extinct species, but it is described here tentatively as an undetermined species of *Tanna*(?).

Conclusive Remarks

Four Late Cenozoic cicadas, *Terpnosia nigricosta* and *Tibicen bihamatus* from the Middle or Late Pleistocene of Shiobara, *Graptopsaltria* aff. *nigrofuscata* from the Middle Pleistocene of Yoshida and *Tanna*(?) sp. from the Early Pleistocene of Kazusa have been described. Of which the first two species from Shiobara never live in the vicinity of the fossil locality at the present time but in the higher forests surrounding Shiobara Hot Spring. This fact supports the deduction, 4–5° lower temperature at that time, drawn from the fossil flora (ENDO, 1935). The third species is more relative to the living species of the mainland of Japan than that of the Ryûkyû Islands, but does not entirely coincide with it. The last species cannot be identified to any living species though it is of a young geologic age.

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