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A Synoptical Table on the Quaternary Stratigraphy of Japan*

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(With 1 Table)

One of the tasks of the Stratigraphic Commission of INQUA (International Union for Quaternary Research) simultaneously the Subcommission on Quaternary Stratigraphy of IUGS (International Union for Geological Sciences) is to compile the stratigraphic schemes for individual regions.** At the time of the Commission held on 31 August 1965 at Boulder (Colorado) during the Seventh International Congress of INQUA in which the author participated, the chairman (F. GULLENTOPS) suggested to prepare the chronostratigraphic table of different countries in three (Early, Middle and Late) or four (Earliest, Early, Middle and Late) units till the next Congress. At the same meeting of the Commission, S. VAN DER HEIDE recommended to compile the table in the form of two columns for each country. The present synoptical table is prepared to follow the above-mentioned comments, originally to be discussed at Prague on 26 August 1968, by request of F. TAKAI, a corresponding member of the Commission. However, under severe political circumstance, the projected meeting at Prague was cancelled.

During this decade, the progress in stratigraphic and geohistoric researches on the Quaternary of Japan is very remarkable by the members of the Quaternary Research Group and the Osaka Group Research Group, especially by young researchers with energetic abilities. The results in progress were summarized by K. KOBAYASHI *et al.* (1965), KOBAYASHI (1965 a, b). Another general description of the Japanese Quaternary was given by TAKAI and TSUCHI (1963).

Two areas are selected as having typical stratigraphical columns. The one is the south Kanto area surrounding Tokyo and including the Boso peninsula, the other is the Kinki district including Osaka, Kyoto and the Biwako (Lake Biwa) basin. The former is the classical Pleistocene area in Japan (MAKIYAMA, 1931) and represented by the Pliocene-Pleistocene marine succession rich in molluscan and foraminiferal fauna (YOKOYAMA, 1922, *etc.*; AOKI, 1964, 1968; KIKUCHI, 1964, *etc.*), and by the Middle-Late Pleistocene tephras ("the Kanto Loam") and well-developed terrace formations (Kanto Loam Research Group, 1965; KOBAYASHI, 1965; NARUSE, 1966. *etc.*). The latter is represented by the Pliocene-Pleistocene lacustrine-marine formations of the

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** Stratigraphic Commission of INQUA, Circular 1, March 1968 (F. GULLENTOPS and G. LÜTTIG), p. 7–8.

Setouchi (Inland Sea) province, by which the succession of the Proboscidean remains and the successive palynological changes are well traced (IKEBE *et al.*, 1966; ITIHARA, 1961; KAMEI, 1966; HUZITA, 1954; TAI, 1966; NIREI, 1968).

1. The Osaka group, the stratotype of which is in the Senriyama hilly area north of Osaka, is the typical Late Pliocene-Early Pleistocene formations in the Kinki district. The group (maximum thickness is ca 600 m) consists of gravels, sands and clays with some thirty tephra intercalations (YOKOYAMA & KUSUKI, 1969). Among these tephras, the Azuki, the Pink and the Yellow tuffs are very useful keybeds in both mapping and correlation works. The lowermost part of the group (below the Yellow tuff in Ma 0-marine clay) is the limnic facies,whereas the upper two thirds consist of alternating marine (numbered as Ma 0 to Ma 10 marine clay in ascending order) and freshwater facies (ITIHARA, 1961; ITIHARA *et al.*, 1966). The Pink tuff is between the Ma 1 and Ma 2 marine sediments; the Azuki tuff is in the Ma 3 clay. The Kobiwako (Paleo-Biwa) group in the Biwako basin (TAKAYA, 1963; ISHIDA *et al.*, 1968; YOKOYAMA *et al.*, 1968) and the Ange group in the Ise bay basin are nearly contemporaneous to the Osaka group, but the latter two range to the Middle (the Kobiwako) or the Lower (Ange) Pliocene in their lower parts, as shown in the table. Moreover, the Kobiwako and the Ange group are exclusively of limnic facies. These formations are unconformably overlain by the successive terrace deposits. The crustal movements began at the later age of the deposition of the Osaka group and still continue at present are named as the Rokko movements (IKEBE & HUZITA, 1966, *etc.*). Proboscidean remains of the Osaka and the corresponding groups are *Stegodon* (*elephantoides, sugiyamai, akashiensis* and *orientalis*) and *Elephas* ("*Archidiskodon*") *shigensis,* the range of each species is shown in the table (IKEBE *et al.*, 1966; KAMEI, 1966, *etc.*). It is a remarkable fact that the *Metasequoia* flora (MIKI, 1953) flourished in the earlier ages suddenly declined somewhat below the Yellow tuff and entirely disappeared between Ma 2 and Ma 3 (below the Azuki tuff) (HUZITA, 1954; ITIHARA, 1961). Climatic changes chiefly realized by the palynological study by TAI (1966) show that the time of first severe cooling was between Ma 2 and Ma 3 (below the Azuki tuff), corresponding to the extinction of the *Metasequoia* flora (NIREI, 1968). A well-preserved crocodile skeleton (*Tomistoma machikanense*) is found from the horizon just below the Ma 8 clay corresponding to a warm age in the palynological-climatic curve (KOBATAKE & KAMEI, 1966). The occurrences of *Elephas* ("*Paleoloxodon*") *naumanni* are restricted in the terrace deposits. Examples of radiocarbon age of the Lower terrace deposits (MAEDA & HUZITA, 1969) and the lower part of the Umeda formation dated by K. KIGOSHI *et al.*, are mentioned in the table ($\times 10^4$ y.) The results of paleomagnetic surveys on tephras interbedded in the Kobiwako and the Ange groups worked out very lately by T. YOKOYAMA *et al.* (ISHIDA *et al.*, 1969; SASAJIMA, 1969), show that the Kobiwako group ranges from the GILBERT reversed epoch up to the early age of the BRUNHES normal epoch, and that the horizon of the Olduvai normal event may possibly lie in the Gamoh

formation.* Details concerning the Osaka group and the related formations should be referred to a paper now in the preparation by M. ITIHARA and the members of Osaka Group Research Group.

2. The Pliocene-Pleistocene formations in south Kanto have been, as previously stated, famous as a standard and classical strata of the said epochs since the early decade of the century. Among many geologists who had treated with these strata or fossils contained, M. YOKOYAMA, H. YABE, H. MATSUMOTO, J. MAKIYAMA, R. TAYAMA and Y. OTUKA would especially be mentioned as pioneer workers. The generally accepted opinion with some disagreements was that the Pleistocene Narita group (including the Tokyo beds) unconformably covering the Pliocene-Miocene Miura group and being overlain by the latest Pleistocene "Kanto Loam". Four stage names (*Kanozanian, Sematian, Naritian* and *Tatikawan* in ascending order) were given to these "Pleistocene" strata by MAKIYAMA (1931).

The type area of the Kazusa group (corresponding to the upper part of the Miura group plus a part of the Narita group *auct.*) has recently been mapped in detail by the staff of the oil-geology section of the Geological Survey of Japan (1961). The problem of Pliocene-Pleistocene boundary has been discussed by many authors from various standpoints (OGOSE, ASANO *etc.*). At present, most generally accepted opinion is that the boundary might correspond to the U6 tephra intercalated in the middle of the Umegase formation, indicated by the sudden increase of population of *Uvigerina akitaensis,* a cool water indicator of benthonic foraminifera (ISHIWADA, 1964). Accepting this view, the occurrences of *Elephas* ("*Archidiskodon*") *proximus* in the area woulld be confined to the Pleistocene. Very recently, NAKAGAWA *et al.* (1969) have shown that the horizon of U6 corresponds to a magnetic porarity event possibly correlated with the Olduvai normal event. Moreover, T. TAKAYAMA has very lately found that the *Globorotalia truncatulinoides* datum in the *Glr. tosaenisis—truncatulinoides* lineage is a little below the U6 tephra.** From these facts, Pliocene-Pleistocene boundary (BERGGREN, 1968) in south Kanto area, may, for the time being, be drawn toward the U6 tephra in the Umegase formation. The horizon of *Stegodon aurorae* (intimately related to *S. akashiensis*) occurred from the Tama hills might be correlated with somewhat above this boundary (TAKAI, 1963). The occurrences of *Stegodeon orientalis* are restricted in the upper part of the Kazusa group (the Nagahama and Kasamori formations). The occurrences of *Elephas* ("*Paleoloxodon*") *naumanni* are confined within the Narita group and terrace formations. The succession of Proboscidean occurrences in Kanto seems to be parallel to those in Kinki.

The Narita group (east to Tokyo, right column in the table) and the Sagami group

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* The Kono tuff in the Gamoh formation and the Senriyama tuff in the Osaka group ca. 60 m below the Yellow tuff (YOKOYAMA & KUSUKI, 1969).

** TAKAYAMA, T.: a paper read before the annual meeting of the Paleontological Society of Japan on 25 January 1969.

(Tokyo and Yokohama area, the left column; the Naganuma, Byobugaura and the Simosueyoshi formation inclusive) are made up of shallow marine sediments in some embayment. They show a great contrast to the open, littoral to deeper neritic nature of sediments of the underlying Kazusa group. Details of the Middle and Late Pleistocene stratigraphy clarified by the tephrochronological and geomorphological investigations will be found in the literature cited (Kanto Loam Research Group, 1961, 1965; Kobayashi, 1965; Kobayashi *et al.*, 1965; Naruse, 1966, 1967). A curve of sea-level changes shown in the table, chiefly after Nakagawa (1967) and Fujii *et al.* (1967), roughly coincides with that of Fairbridge.

3. Referring the successions in Kanto and Kinki, and considering available data from other parts in Japan, the following four chronostratigraphic divisions may provisionally be suggested:

(1) *Kanozanian* (Makiyama, 1931, emended now)—Type: Higashihigasa member of the Umegase formation and the lower part of the Ichijuku sands, Chiba pref., Kanto (marine). Base: horizon toward the U6 tephra. *Stegodon sugiyamai*, *akashiensis* and *aurorae* (related to *Stegodon trigonocephalus* from Djetis and Trinil of Java); *Elephas* ("*Archidiskodon*") *proximus* and *shigensis*. Declining age of the *Metasequoia* flora. Corresponding to Earliest (preglacial) Pleistocene, or preferably Eo-pleistocene.

(2) *Sanukian* (Ikebe, 1948, 1954)—Type: Nagahama gravels, Mandano and Kasamori formations in Chiba pref., Kanto (marine). *Stegodon orientalis*, *Elephas* ("*Archidiskodon*") *shigensis* and *proximus*. Early Pleistocene.

(3) *Manzakian** (Yokoyama, 1922)—Type: Whole section of the Narita group in Chiba pref., Kanto (marine). Very rich in mollusca (the Manzakian fauna of Yokoyama). Predominant occurrences of *Elephas* ("*Paleoloxodon*") *naumanni*. Middle Pleistocene.

(4) "*Tachikawan*"* (Makiyama, 1931)—"Kanto loam" above and including the Shimosueyoshi loam with terrace gravels between them, Tokyo (terrestrial and fluvial). The stage name is tentative, because "Tachikawa" is used as lithostratigraphic name. Survival of *E. naumanni*; *E. primigenius* in north Japan. Late Pleistocene.

4. Glacial succession in Europe and European standard succession together with the magnetic polarity scale in the left side of the table are chiefly according to Selli (1967a, b), Berggren (1967, 1968), and Cox & Dalrymple (1967). By critically evaluating the above mentioned recent discoveries in the Pliocene-Pleistocene strata of Japan, and by accepting the opinions expressed by Selli and Berggren, one is now approaching the possibility of correlating the Japanese Pleistocene events to the European standard as shown in the table (Ikebe, 1968; Kobayashi, 1969). The cool phase indicated by benthonic foraminifera in the Otadai formation (Aoki, 1968) and

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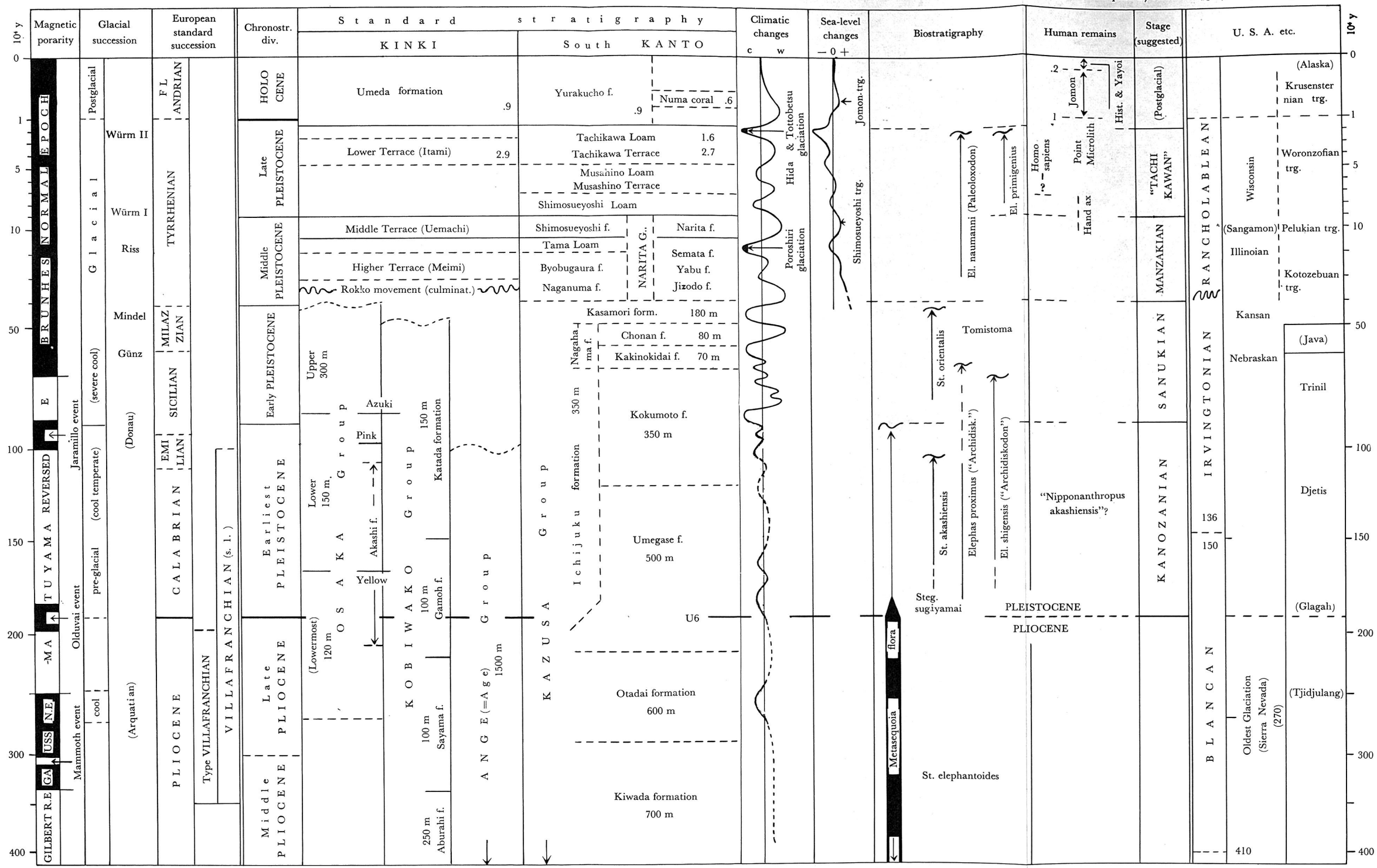
* Both the *Manzakian* and "*Tachikawan*" might possibly be divided into three (or four) substages respectively.

SYNOPTICAL TABLE ON THE QUATERNARY OF JAPAN

Compiled by N. IKEBE, July 1968, revised Jan. 1969.



by palynological study toward the base of the Osaka group, might possibly be correlated with the Arquatian cool phase (LONA, after VENZO, 1968) in the Piacenzian stratotype in Italy, the Deadman Pass glaciation of 2.7–3.1 m.y. in Sierra Nevada (CURRY, 1966) and the "Pliocene-Pleistocene boundary" of ca. 3.0 m.y. in the Lomita marl in California (BANDY, 1968). KAHLKE (1968) has recently referred to the problem of correlation of the Osaka group with the Villafranchian (*s.l.*) based on the Proboscidean lineage.

In closing this short memorandum explanatory to the synoptical table, grateful respects should be paid to the members of the Kanto Loam Research Group and the Osaka Group Research Group, without their fruitful works the compilation of the present table would not have been possible.

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Errata for the Table.

Column:	For:	Read:
South KANTO	Musahino Loam	Musashino Loam
Climatic changes	Tottobetsu	Tottabetsu
Biostratigraphy	(Paleoloxodon)	("Paleoloxodon")