

Occlusal Surface Pattern of Lower Molars in Fossil Hominids with Special Reference to Peking Man*

By

Hajime SAKURA

Department of Anthropology, National Science Museum, Tokyo

Introduction

Since GREGORY and HELLMAN (GREGORY and HELLMAN, 1926; HELLMAN, 1928) defined the concept of "Dryopithecus pattern", and classified its modifications in recent hominid dentitions, the occlusal surface pattern of lower molar has been studied by many investigators to clarify the variation of the character in various recent human racial populations. The results previously obtained show different proportional occurrence of the modified or reduced patterns in different populations, especially on second and third molars. If Dryopithecus pattern is the original status in hominid as it is in pongid, when and how its modification occurred should be an interesting problem. Unfortunately, researches of the character on fossil hominids to solve this problem have been rather fragmentary.

The present study is intended to examine this character on some fossil hominid groups, and to estimate their phylogenetic relationships with recent populations as well as probable course of reduction of the character through hominid evolution and diversification.

Classification of the Pattern

Occlusal surface pattern is usually classified based on two different morphological elements, i.e., the groove pattern and the cusp number. "Dryopithecus pattern" means the pattern of such a molar which has five distinct cusps, and the groove system of which has a Y-shaped part when the buccal side of the tooth is orientated upwards. The "Y" is formed by the boundary groove of the hypoconid as its two arms, and the groove between metaconid and entoconid as its stem (Cf. Fig. 1, upper left). This pattern is designated as Y5.

In human molars with reducing tendency, the cusp number is modified to four, and groove pattern to +. JØRGENSEN (1955) added another category of groove pattern, X, and further defined the +-pattern precisely as that either contact of the two diagonal pairs of cusps does not exceed 0.2 mm.

* This study was preliminarily presented at the 30th Joint Meeting of the Anthropological Society of Nippon and the Japanese Society of Ethnology, held in Nagoya, 1976 (SAKURA, 1976).

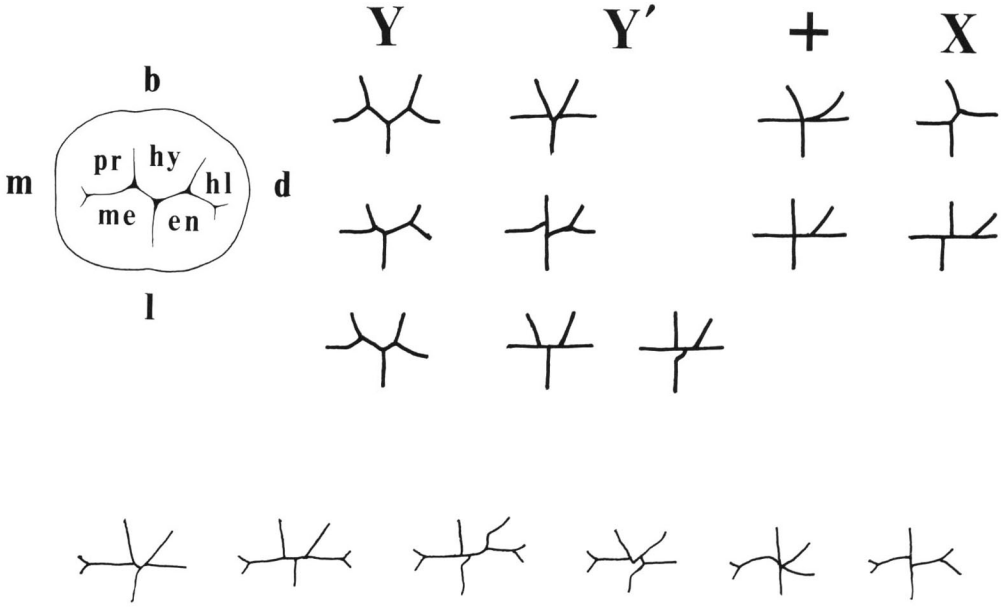


Fig. 1. Classification of occlusal groove pattern in lower molar.

Upper left: Occlusal view of lower molar with typical Y5 (*Dryopithecus*) pattern. m, mesial; d, distal; b, buccal; l, lingual sides. pr, protoconid; hy, hypoconid; hl, hypoconulid; me, metaconid; en, entoconid.

Upper right: Schema of Some variations of the groove patterns Y (HELLMAN), Y' (SAKURA), + (HELLMAN), and X (JØRGENSEN).

Bottom row: Examples of the groove pattern Y' which appeared in lower molars of Peking man. (Cf. Fig. 2)

It should be noted that the typical Y-pattern is characterized not only by the broad basal contact of hypoconid with both metaconid and entoconid, but also by the lingual protrusion of hypoconid at the central fovea, that is, by angular arms of Y. However, there frequently occurs such Y-pattern that is very close to + -pattern in nature, which I would propose to designate as "Y'-pattern", and consider to be intermediate between Y and +.

The category of groove pattern Y' is identified in one of the following cases (Fig. 1):

- (1) The basal contact of hypoconid with either of metaconid and entoconid is very small, and does not exceed 0.5 mm.
- (2) The central groove is nearly straight, and the two arms of Y do not make a marked angle, at the central fovea. In other words, no lingual protrusion of the hypoconid.
- (3) The mesial arm and the stem of Y have nearly straight and smooth continuation at the central fovea.

Fig. 1 gives schema of some variations of the groove patterns including newly proposed Y' with its examples found in the teeth of Peking man.

If a tooth does not show regular arrangement of cusps and grooves, and can not be classified into any of the patterns defined above, it is included in the category "undefinable". Teeth of this category are frequently seen in third molars. Of course, other category "not observable" may be cases, mostly caused by much loss of enamel structures on the occlusal surface of the tooth.

Case with cusp number six is tentatively described separately from that with five cusps, though these two categories may be regarded to have equivalent values in phylogenetical meaning.

Materials

Occlusal surface patterns in lower molars were examined on three fossil hominid

Table 1. Occurrence of the occlusal surface patterns in lower molars of *Australopithecus* from South and East Africa.

Pattern	Species	Occurrence		
		M ₁	M ₂	M ₃
Y -6	<i>A. africanus</i>	3 Taung, rl (D) Sts 37, l (D)	0	0
	<i>A. robustus</i>	1 SK 25, r (R)	1 SK 25, r (R)	0
-5	<i>A. africanus</i>	6 Sts 9, r (R) Sts 24, r (R) MLD 2, rl (RD) OH 7, rl (D)	4 Sts 52b, r (R) MLD 2, rl (RD) OH 7, l (D)	0
	<i>A. robustus</i>	3 SK 6, l (R) SK 23, l (R) SK 843, l (R)	3 SK 1, l (R) SK 23, l (R) SK 843, l (R)	3 SK 6, r (R) SK 22, r (R) SK 841, l (R)
Y' -5	<i>A. africanus</i>	1 T.M. 1518, r (R)	0	0
+ -5	<i>A. africanus</i>	0	1 Sts 4, l (R)	0
Undefinable	<i>A. africanus</i>	0	0	1 Sts 52b, r (R)
	<i>A. robustus</i>	0	0	1 SK 23, l (R)

Sts: Sterkfontein (also T.M. 1518).

MLD: Makapansgat.

SK: Swartkrans.

OH: Olduvai (OH 7 is a specimen of "Homo habilis", but attributable to *A. africanus*).

groups: *Australopithecus*, Peking man and Neanderthals. Materials for the examination are all reproductions of original specimens, except for the teeth of Amud man. The reproductions consist principally of sketches and photographs which have been presented in various publications. The authors of these source publications, and their symbols that will appear in the tables are as follows:

GORJANOVIĆ-KRAMBERGER, 1906 (G)

WEIDENREICH, 1937 (W)

MCCOWN and KEITH, 1939 (M)

ROBINSON, 1956 (R)

DAY, 1965 (D)

Those reproductions of teeth which are in the category "not observable" or lack enough details are omitted.

Results

Australopithecus (Table 1)

In the lower molars of *Australopithecus*, the cusps and ridges are mostly well-

Table 2. Occurrence of the occlusal surface patterns in lower molars of Peking man (*Sinanthropus*).

Pattern	Occurrence		
	M ₁	M ₂	M ₃
Y -5	6 Sin 34, l (W) Sin 35, r (W) Sin 36, l (W) Sin 97, r (W) Sin 99, r (W) Sin 102, l (W)	1 Sin 43, l (W)	0
-4	0	0	1 Sin 50, l (W)
Y' -6	0	3 Sin 44, l (W) Sin 107, r (W) Sin KI, l (W)	0
-5	2 Sin 46, r (W) Sin 98, r (W)	2 Sin 45, r (W) Sin 108, r (W)	1 Sin 115, r (W)
-4	0	0	1 Sin 114, r (W)
+ -5	0	0	2 Sin 52, l (W) Sin 116, l (W)

Sin: *Sinanthropus* (*Homo erectus*).

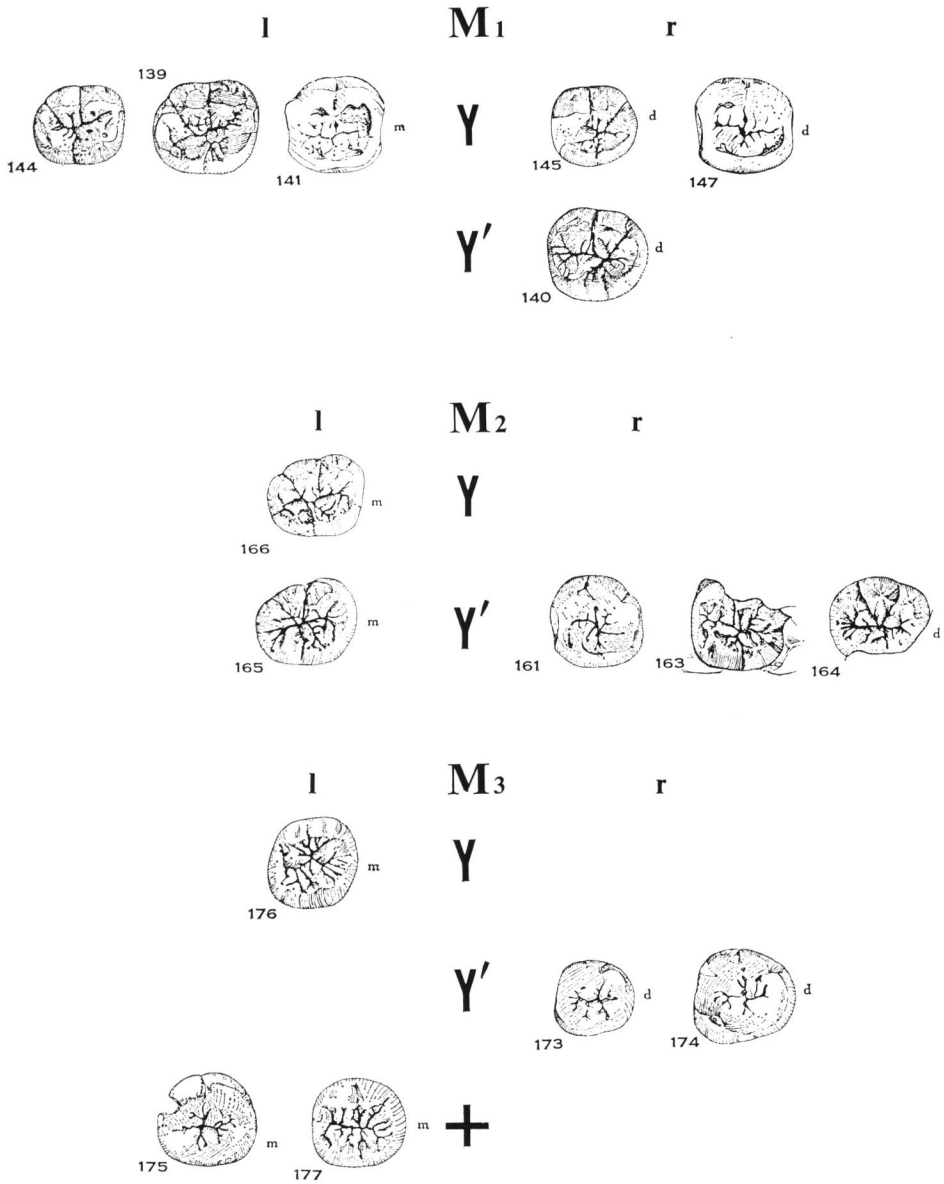


Fig. 2. Occlusal views of lower molars of Peking man.

Figures chosen from WEIDENREICH (1937), and arranged by tooth kind, groove pattern, and side. (Natural size)

Figure nos.: 144, Sin 34; 139, Sin 36; 141, Sin 102; 145, Sin 97; 147, Sin 35; 140, Sin 98; 166, Sin 43; 165, Sin 44; 161, Sin 45; 163, Sin 108; 164, Sin 107; 176, Sin 50; 173, Sin 114; 174, Sin 115; 175, Sin 116; 177, Sin 52.

developed and the grooves or furrows are relatively deep and distinct. Therefore, occlusal surface patterns of them have little tendency to reduction, especially in the first and second molars. No clear difference in occurrence of the patterns is found between two species, *A. africanus* and *A. robustus*. In the first molars, all the 13 specimens bear the typical *Dryopithecus* pattern, i.e., Y5 or Y6. In the nine second molars, the same condition is true but one exception, which bears +5. In the six third molars, one case of Y'-pattern and two cases of category "undefinable" are found. This means that the third molar shows a tendency to have atypical cusp and groove arrangements even in *Australopithecus* as in other hominid groups.

Table 3. Occurrence of the occlusal surface patterns in lower molars of Neanderthals from Europe and West Asia

Pattern	Occurrence		
	M ₁	M ₂	M ₃
Y -5	11 Gibraltar, r (W) Moustier, r (W) Ehringsdorf, l (W) Krapina, l (W) Tabun S. III, l (M) Tabun Eb, r (M) Shukbah, r (M) Skhul I, r (M) Skhul X, l (M) Amud I, rl	7 Moustier, r (W) Moustier, l (M) Ehringsdorf, l (W) Tabun S. IV, l (M) Skhul I, r (M) Skhul X, l (M) Amud I.M., r	0
-4	0	1 Heidelberg, r (W)	1
Y'	0	0	0
+ -6	0	1 Gibraltar, r (W)	0
-5	0	1 Krapina, r (G)	0
-4	0	1 Amud I, l	0
X -5	1 Krapina, l (G)	0	2 Heidelberg, r (W) Krapina, r (G)
-4	0	1 Amud I, l	0
Undefinable	0	0	3 Moustier, r (W) Krapina, l (G) Krapina, ? (G)

Amud I, Amud I.M. (Amud Isolated Molar): SAKURA, 1970.

Peking Man (Table 2, Fig. 2)

In the first and second molars of Peking man, a considerable proportion of groove pattern Y' is found, although the sample size is small. Namely, two cases out of eight first molars, and five cases out of six second molars have Y'-pattern. But cusp number is in all cases still five or six. In the third molars, one case each of Y4, Y'5, and Y'4, and two cases of +5 are observed. None of these bears typical *Dryopithecus* pattern.

Neanderthals (Table 3)

In the Neanderthal lower first and second molars, some reduced patterns seem to occur in respect to both the groove pattern and the cusp number, which are more frequent in the second molars, though the majority of the molars still retain *Dryopithecus* pattern. In the 12 second molars, four teeth have groove pattern + or X, whereas three have cusp number four. Of the five third molars, two are observed to have X5 pattern, but the patterns of remaining three are all undefinable.

Summary of the results (Table 4)

The results on the three fossil hominid groups mentioned above can be summarized as follows:

(1) Most of the examined first molars bear typical *Dryopithecus* pattern in all the three groups. Little difference in occurrence of occlusal surface patterns is seen among groups. None of them reveals reduction of cusp number to four. The only signs of reduction are two cases of groove pattern Y' in Peking man and only one case of + in Neanderthals.

Table 4. Comparison of occurrences of the occlusal surface patterns among three fossil hominid groups.

Pattern	<i>Australopithecus</i>			Peking Man			Neanderthals		
	M ₁	M ₂	M ₃	M ₁	M ₂	M ₃	M ₁	M ₂	M ₃
-6	4	1	0	0	0	0	0	0	0
Y	9	7	3	6	1	0	11	7	0
-4	0	0	0	0	0	1	0	1	0
-6	0	0	0	0	3	0	0	0	0
Y'	0	0	1	2	2	1	0	0	0
-4	0	0	0	0	0	1	0	0	0
-6	0	0	0	0	0	0	0	1	0
+	0	1	0	0	0	2	0	1	0
-4	0	0	0	0	0	0	0	1	0
X	0	0	0	0	0	0	1	0	2
-4	0	0	0	0	0	0	0	1	0
Undefinable	0	0	2	0	0	0	0	0	3
<i>Total</i>	13	9	6	8	6	5	12	12	5

(2) On the second molars, *Australopithecus* teeth are still scarcely modified from *Dryopithecus* pattern. But considerable tendency of reduction seems to appear in the other two groups in different ways. In Peking man, most of the teeth have a little modified groove pattern Y', but all of them hold five or six cusps. In Neanderthal teeth, modified groove patterns, + and X, and reduced cusp number, 4, are both observed.

(3) On the third molars, modified occlusal surface patterns and undefinable pattern increase in proportion. Because of the increase of the latter condition and also of the small sample size, difference in occurrence of the patterns among groups is not clear. But it is noticed that only in *Australopithecus*, Y5-pattern occurs in a half of the teeth.

Discussion and Conclusion

The occlusal surface pattern in hominid has been considered to have a tendency to reduction or modification, changing from the original Y5-pattern to the reduced +4-pattern, in the course of evolution. The transitional two patterns, Y4 and +5, is lumped by STESLICKA (1948) in one "median" group, and DAHLBERG (1949) gives them an equivalent tentative value of modification, and supposes that actual evolutionary change from Y5 to +4 may have proceeded through either of the two transitional or intermediate patterns.

JØRGENSEN (1955) emphasized that the groove pattern and the cusp number are two elements of the occlusal surface pattern independent one another and, therefore, they should be analyzed separately. He studied the pattern in recent Danes and Dutchmen, and made a two-dimensional diagram expressing proportions of Y-pattern and 5-cusps in individual populations, on which his own and many previous data on various racial populations were plotted. He pointed out of this diagram a general tendency in second and third molars first to reduce the frequency of the Y-pattern, and only later to reduce the cusp number essentially. But he failed to note the fact that when second molars are taken into account, Negroid and Caucasoid races seem to share a tendency to reduce the groove pattern and the cusp number simultaneously, and only Mongoloid races have an apparent tendency as mentioned by him.

SUZUKI and SAKAI (1973) gave a similar diagram as JØRGENSEN's, using a little greater number of populations than the latter (Fig. 3), and stated on second molars quite reasonably that:

"Among Negroids and Caucasoids regression in the Y pattern and number of cusps take place nearly in direct proportion, whereas among Mongoloids the two occur in different rates, the former surpassing the latter."

In fact, second molar should be considered to be the most appropriate material of all three kinds of lower molar, to examine probable course of reduction of occlusal surface pattern, because first molar is in general too stable against reduction, and third molar is frequently fairly modified to have irregular arrangement of mor-

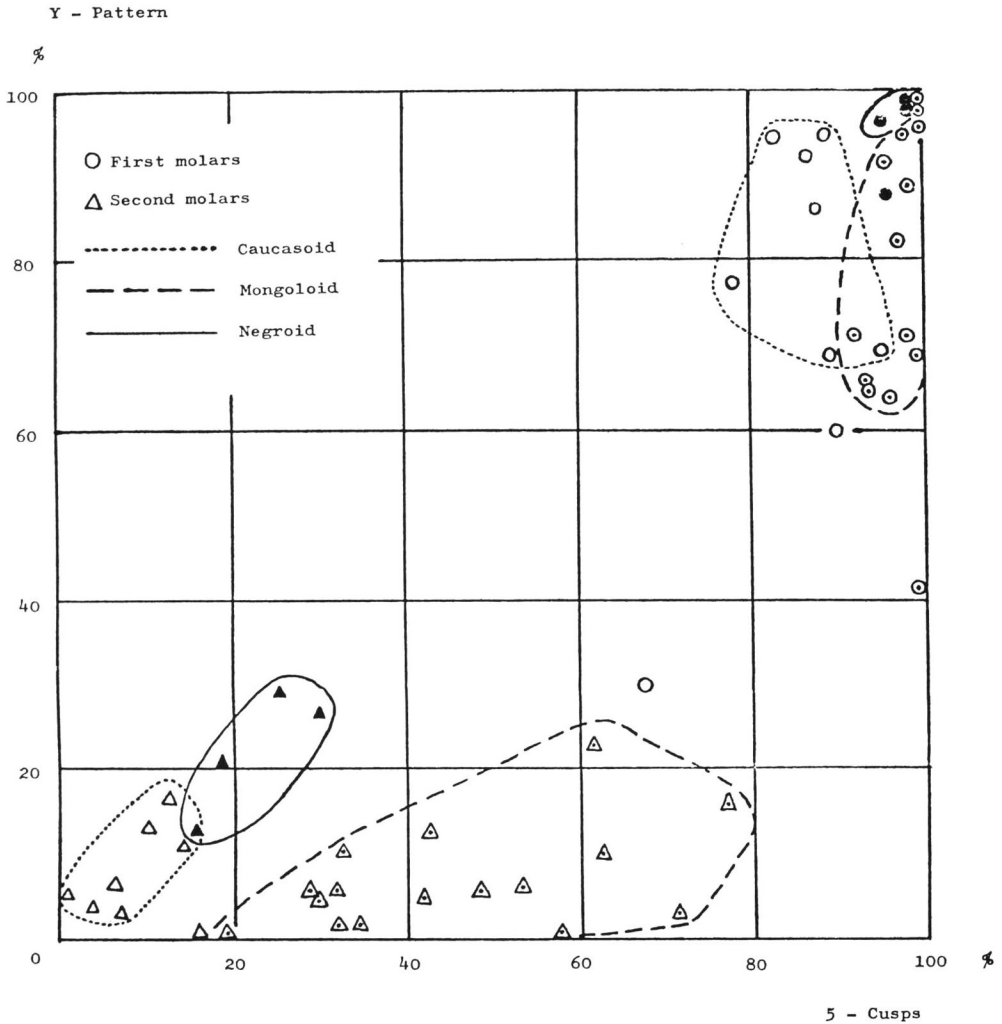


Fig. 3. Correlation diagram showing the proportionate frequency of Y-pattern and five cusps on the lower molars in different populations. From SUZUKI and SAKAI (1973: Fig. 39), by courtesy of Prof. T. SAKAI.

This diagram is drawn in the same method as the JØRGENSEN'S (1955: Fig. 2), but the number of populations included is greater than that of the latter, and data on third molars are omitted.

phological elements, and thus to make the frequency of the patterns itself nearly meaningless.

The results of the present study on second molars are employed to draw another similar diagram, Fig. 4, in which the particular positions of three fossil hominids are presented, together with the ranges of recent three main racial groups. Based on

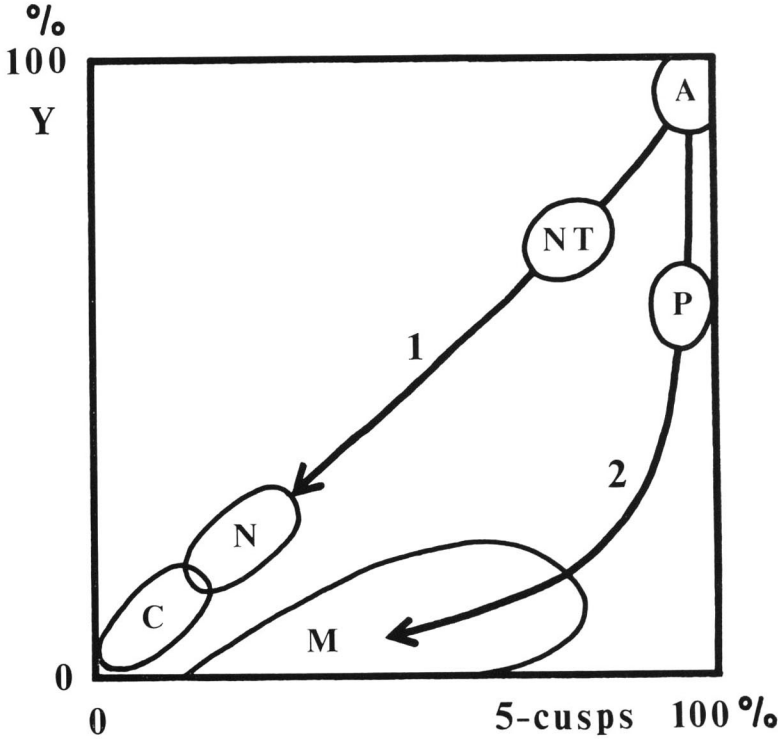


Fig. 4. Two hypothetical courses of hominid evolution in respect to the occlusal surface pattern of lower second molar.

1: From the original status of *Australopithecus* (A), through Neanderthal (NT), to recent Negroid (N) or Caucasoid (C).

2: From *Australopithecus*, through the status of Peking man (P), to recent Mongoloid (M).

In this diagram, proportion of "5-cusps" means that of five and six cusps combined. Proportion of the groove pattern "Y" for three fossil groups is calculated as if the intermediate pattern Y' has about a half value of Y. Ranges of the recent racial groups are basically according to SUZUKI & SAKAI (Fig. 3).

these positions of all the groups in this diagram, and possible phylogenetical relationships between the fossil and recent hominid groups, especially between Peking man and recent Mongoloids, it is naturally conceived that two differential courses may have existed in human evolution, as shown in Fig. 4. One has proceeded from the status of *Australopithecus*, through that of Neanderthals, and to recent Negroid or Caucasoid, and the other has proceeded through the status of Peking man, to recent Mongoloid. And the fossil evidence in the present study, though some reservation is needed because of the small sample size, directly supports the above-mentioned SUZUKI and SAKAI's view.

Further, this concept of differential courses in human evolution is in full concordance with my previous conclusions of the study on *fovea anterior* in lower and upper molars (SAKURA, 1979, 1980), and also with the opinion of WEIDENREICH (1937), supposing the close phylogenetical relationships between Peking man and recent Mongoloid races.

Acknowledgements

I wish to express my thanks to Dr. Bin YAMAGUCHI, Department of Anthropology, National Science Museum, Tokyo, for his valuable advice, and to Miss Akiko NAKATSUKA and Mr. Shuichiro NARASAKI, for their assistance to complete the manuscript.

This study was partly supported by the grants from the Ministry of Education, Science and Culture, Japan.

References

- DAHLBERG, A. A., 1949. The dentition of the American Indian. *In: (W. S. LAUGHLIN, ed.) Papers on the Physical Anthropology of the American Indian: 138-176.* New York, Viking Fund Press.
- DAY, M., 1965. *Guide to Fossil Man.* xvi+289 pp. Cleveland & New York, The World Publishing Co.
- GORJANOVIĆ-KRAMBERGER, K., 1906. *Der diluviale Mensch von Krapina in Kroatien. Ein Beitrag zur Paläoanthropologie.* 59-278 S., Taf. 1-14. Wiesbaden, C. W. Kreidel's Verlag.
- GREGORY, W. K. and M. HELLMAN, 1926. The dentition of *Dryopithecus* and the origin of man. *Anthrop. Papers Am. Mus. Nat. Hist.*, **28**, Pt. 1: 1-123, 25 pls.
- HELLMAN, M., 1928. Racial characters in human dentition. *Proc. Amer. Phil. Soc.*, **67**: 157-174.
- JØRGENSEN, K. D., 1955. The *Dryopithecus* patterns in recent Danes and Dutchmen. *J. D. Res.*, **34** (2): 195-208.
- MCCOWN, T. D. and A. KEITH, 1939. *The Stone Age of Mount Carmel: The Fossil Human Remains from the Levallois-Mousterian*, Vol. 2. xvii+390 pp., 27 pls. Oxford, Clarendon Press.
- ROBINSON, J. T., 1956. *The Dentition of the Australopithecinae.* vii+179 pp. Pretoria, Transvaal Museum.
- SAKURA, H., 1970. Dentition of the Amud Man. *In: (H. SUZUKI and F. TAKAI, eds.) The Amud Man and His Cave Site*, IX: 207-229, pls. 33-38. Tokyo, Univ. of Tokyo.
- SAKURA, H., 1976. Occlusal surface pattern of mandibular molars in Peking Man. *J. Anthrop. Soc. Nippon*, **84**: 295. (in Japanese)
- SAKURA, H., 1979. Variations of *Fovea anterior* in lower molars among some fossil and recent hominids. *Bull. Natn. Sci. Mus., Tokyo*, Ser. D, **5**: 1-11.
- SAKURA, H., 1980. Variations of *Fovea anterior* in upper molars among some fossil and recent hominids. *Bull. Natn. Sci. Mus., Tokyo*, Ser. D, **6**: 1-8.
- STESLICKA, W., 1948. The *Dryopithecus*-pattern in human lower molars. *Ann. Univ. Mariae Curie-Sklodowska, Lubin*, 111: 7 (cited in JØRGENSEN, 1955).
- SUZUKI, M. and T. SAKAI, 1973. *The Japanese Dentition: Morphological Study of the Dental Characteristics of the Permanent Teeth in Recent Japanese.* 258 pp. Personal publication.
- WEIDENREICH, F., 1937. The dentition of *Sinanthropus pekinensis*. A comparative odontography of the hominids. *Palaeontologia Sinica*, no. 101 (N.S.D. no. 1): i-v, 1-180, pls. 1-36, diagrams 1-49.

