4. Gazella (Protetraceros) gaudryi (Schlosser) and Gazella dorcadoides (Schlosser).

By

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(With Plates I and II.)

In 1935 I published in the Palaeontologia Sinica a paper entitled »Cavicornier der Hipparion-Fauna Nord-Chinas». One chapter in this paper (pp. 75—106, text figs. 54—81 and 87 b—d, Plates X—XII) was devoted to the *Gazellinae*. Later it turned out that the material at my disposal was only about half of the material of this group collected by Professor ZDANSKY and that a great number of *Gazella* remains was still unprepared and stored away. The reason was that the preparation had had to be interrupted. After my paper was published it became possible to continue the preparation, and a few good skulls and a great quantity of fragments of different kinds thus became available for study.

Ever since I have hoped to get time to describe this new material. A recent paper by P. TEILHARD DE CHARDIN and M. TRASSAERT »Cavicornia of South-Eastern Shansi» Nanking 1938 has given me reason to realize this plan without further delay.

The leading principle in my earlier treatment of the genus *Gazella* was (1935 p. 105): »Bei der Beschreibung der fossilen Gazellen aus China muss man von den Zähnen ausgehen, weil bei der Ausarbeitung von SCHLOSSERS klassischer Monographie nur Gebisse vorlagen.» Following this principle I was able to identify two types of dentitions, one covering *Gazella (Protetraceros) gaudryi* (SCHLOSSER) and one *Gazella dorcadoides* SCHLOSSER, and possibly also a third type described under the heading of *Gazella sp.* The specific names used were in the first place those proposed by SCHLOSSER, but with much hesitation I tried to identify my *Gazella sp.* with *Gazella paotehensis* TEILHARD & YOUNG 1931. Among the »*Gazella dorcadoides*-ähnlichen Antilopen» (l. c. p. 90) I also included SCHLOSSER's species *G. altidens*, to which species the lower teeth described by SCHLOSSER in 1903 were supposed to belong, but not the upper teeth described and figured

in the same paper. As will be seen later on, this was a somewhat unfortunate proceeding.

Regarding *Gazella paotehensis* I have unintentionally treated this species in a way, which has made it seem, as if I wanted to cancel it. I certainly had not any such intention. On the contrary, I did my very best to recognize the species among my own material, a reasonable thing to do, as the type material of *G. paotehensis* was found at a locality (Chi-Chia-kou), where a great part of the material now in Uppsala was collected (at least one of the specimens collected by TEILHARD & YOUNG seems to have come from ZDANSKY's locality 109). I cannot see that there can be any objection to the designation *Gazella sp.* (?*paotehensis*): the question-mark cannot invalidate the species name. But in my list of species on page 105 »*G. sp.* (?*paotehensis*)» is wrong, it ought to have been: »*Gazella paotehensis* (the *Gazella* sp. described above possibly belongs to this species)». I beg to apologize to Professor TEILHARD and Dr YOUNG for this lapsus.

I must however admit that the species *Gazella paotehensis* still puzzles me. It is stated by TEILHARD & TRASSAERT in 1938 (p. 9) that the species is »based on *associated* horn-cores and lower jaws». This statement can only refer to the type material (»based on»!), and not to a material from K'ingyang collected by LICENT (l. c. p. 10). In 1931 the material is described as follows (l. c. p. 36): »The type of this new form is the frontal part of a skull, with the two horn-cores preserved, and a palate with the teeth belonging to the same individual. Another palate was found with the associated lower jaw.» The type thus is the frontal and the palate associated with it, and (if the information given in 1931 is correct) the lower jaw belonging to another palate can under no circumstances be said to be associated with the horn-cores (see p. 104).

Before I enter on the main subject, I think it is necessary to investigate how SCHLOSSER himself understood his two species, *Protetraceros gaudryi* and *Gazella dorcadoides:*

***Protetraceros* (now *Gazella*) *gaudryi*.** From SCHLOSSER's description (1903 p. 136) I will quote only a few characters, which obviously distinguish the species from *Gazella dorcadoides* (many of the other characters mentioned by SCHLOSSER are rather insignificant): The lower premolars are rather simple. P_3 and P_4 have »einen etwas zurückgeschobenen . . . coulissenartig ausgebildeten Innenhöcker, der aber an P_3 wesentlich schwächer ist als an P_4. P_2 war nur halb so lang als P_3.» See also Pl. XI, fig. 18 (l. c.); notice the somewhat more complicated P_4 in fig. 23. The latter is important, as it is associated with two well preserved molars typical of the species. Lower molars: »In der Mitte der Innenseite verläuft eine breite und ziemlich tiefe verticale Furche.» Basal pillars can sometimes be found also on M_3. They decrease in size from M_1 to M_3. — Upper jaw: »Die

Prämolaren haben den nämlichen Bau wie bei den Palaeomeryciden, nur ist P^4 etwas plumper und P^2 stark in der Länge gezogen.» On the molars there are no basal pillars. »Die Verticalfalten an der Vorderaussen- und der Hinteraussenecke sowie der in der Mitte der Aussenseite sind kräftig entwickelt, ebenso die Rippen an den beiden Aussenhügeln, jedoch ist die des vorderen bedeutend stärker als die des hinteren.» These characters can be clearly seen in Pl. XI figs. 14 and 21.

p. 138: »Von den oben beschriebenen kleinen Antilopen aus China unterscheidet sich Protetraceros Gaudryi ohne Weiteres durch die relativ geringe Höhe der Zahnkronen und durch die Länge und den primitiven, Cervidenähnlichen Bau der Prämolaren. Dagegen kommt er der Gazella brevicornis von Pikermi sehr nahe, nur sind bei dieser die unteren Prämolaren viel zierlicher und die beiden letzten auch gestreckter, auch haben die unteren Molaren keine Aussenfalte am Vorderrande.»

p. 188: »Protetraceros Gaudryi nannte ich eine kleine brachyodonte Antilope aus der Waldfauna des chinesischen Pliocäns, . . .»

The most important characters according to SCHLOSSER thus seem to be the comparatively brachyodont dentition and the length of the premolars. Other characters, to which I have attached much importance, for instance the deep depression in the middle of the inner side of the lower molars and the presence of a well developed rib on the outer side of the metacone, were observed by SCHLOSSER and are clearly seen in his figures.

Gazella dorcadoides, p. 129: Lower molars: »Ihre Innenseite trägt nur ganz schwache Verticalrippen an den Innenhöckern, und an der hinteren und vorderen Ecke je eine sehr scharfe Randfalte. Einen Basalpfeiler hat nur der erste Molar und auch hier bleibt er sehr niedrig . . . Die hintere und die mittlere Falte sind zuweilen abnorm stark entwickelt, reichen aber auch dann nur bis zur halben Höhe des Zahnes. Der untere Theil der Innenseite ist stets fast vollständig flach.» — Upper jaw: »Gleich dem folgenden P^3 ist auch P^2 fast ebenso breit als lang . . . Mit Ausnahme des M^3 verjüngen sich die M, besonders M^1, sehr stark gegen die Basis zu. Nur der vordere Aussenhöcker trägt eine deutliche Verticalrippe.»

p. 130: »Eine umgemein ähnliche, aber etwas mehr hypselodonte Form kommt in Maragha in Persien vor» (compare BOHLIN 1935 p. 103) . . . »Dagegen ist Gazella brevicornis Gaudry . . . nicht blos kleiner, sondern auch augenscheinlich weniger hypselodont. Die Verticalrippen an den Innenhöckern der unteren und den Aussenhöckern der oberen M sind viel kräftiger und die oberen Prämolaren noch viel primitiver, denen der Hirsche ähnlicher . . .»

p. 187: »Die Prämolaren des Oberkiefers sind schon sehr complicirt und die Molaren haben beträchtliche Höhe erreicht.»

Finally, when SCHLOSSER in ZITTEL's »Grundzüge» (4th German ed.

p. 590) figures this species, the upper teeth (1903 Pl. XI fig. 1) and a couple of distinctly hypselodont lower molars are chosen.

Thus, so far as I can understand, SCHLOSSER was above all impressed by the hypselodonty and by the form of the anterior upper premolars. The flat inner side of the lower molars and the absence of a rib on the outside of the metacone, characters which I regard as important, were also originally observed by SCHLOSSER.

SCHLOSSER's material is comparatively very poor, and it is quite natural that among a lot of isolated teeth some must have been difficult to identify and some might have been wrongly identified, for instance the P_4 in Pl. XI, fig. 8 (l. c.). The characters of this tooth are, however, not taken into consideration by SCHLOSSER in any discussion of the species. It is evident that the material belongs to two distinct species and that these species form the basis for further study of the pontian gazelles from China. At least the teeth of the *Gazella gaudryi* type seem to occur in what may prove to be different species (see below), and one should perhaps have cancelled SCHLOSSER's names as species names and let them designate stages in the evolution of the gazelline dentition, as has been done with *Cervavus* (ZDANSKY »Fossile Hirsche Chinas» 1925) and (»*Strepsiceros*») *praecursor* (BOHLIN 1935). There is, however, no doubt about the genus, and one reason, why I have adopted SCHLOSSER's species (also in other cases when the genus could not be doubted and the teeth could not be distinguished from those in my own material), is to prevent that they may appear in faunal lists as equal in value to species based on a more complete material. I suppose that TEILHARD & YOUNG attempted to identify one of their species with *G. gaudryi* for the same reason. I did not realize before the paper by TEILHARD & TRASSAERT appeared that the species described by SCHLOSSER were supposed by these authors to be identical (or almost so, l. c. p. 8), or I would in 1935 have entered on a more thorough discussion of the differences (about *Gazella gaudryi* TEILHARD & YOUNG 1931 see below p. 91).

In my paper (1935) the dentition of *Gazella gaudryi* was characterized as follows (pp. 82—83, extract): »der P_4 ist . . . ein symmetrischer rundlich dreieckiger Zahn wie der von SCHLOSSER abgebildete, der P^3 zeigt dieselbe Schiefheit, und der P^2 ist in gleicher Weise im Verhältnis zu den hinteren P lang und schmal. Die Oberkiefermolaren haben niedrige Kronen, die Rippen und Falten an der Aussenwand treten stark hervor (auch die hintere Rippe) . . . Die Unterkieferprämolaren sind vom selben Bau wie die in SCHLOSSER's Material vorhandenen . . . Die Unterkiefermolaren haben hinter der Mittelfalte eine tiefe Einkerbung . . .» As I have pointed out in the same place, the size of some of the teeth (premolars) in the material

described by SCHLOSSER is close to the maximum or minimum observed on my material, but the structure is in all cases the same. TEILHARD & TRASSAERT say (1938 p. 6): »We do not see therefore why Bohlin did not accept the diagnosis of Teilhard & Young (Bohlin 1935, p. 75) and used the name *gaudryi* for a somewhat different and larger form.» The size of my material agrees quite well with the measurements given by SCHLOSSER, as is seen from the following table:

Length	SCHLOSSER 1903	Remeasured by the author	Average BOHLIN 1935 pp. 100—103
P_2	5.3	—	5.5
P_3	7.2	7.6	8.1
P_4	8	8.1 8.7	8.7
M_1	9.5 10	8.9	8.5
M_2	11 12	10.1	10.2
M_3	14 15	15 16	15.4
DP_2	5	—	4.9
DP_3	8.5	8.2	7.7
DP_4	11	12.2	12.3
P^2	8.3	8.9 ?9	8.3
P^3	7.6	8.3 8.4	7.7
P^4	7	7.1 7.0	6.7
M^1	10	10.7	9.0
M^2	11.5	11.7	11.2
M^3	11.5	—	11.4
DP^3	8.5	8.3	9.2
DP^4	8.5	8.9	9.9

It is evident that on an average my material is even a little smaller than that measured by SCHLOSSER, in most cases the difference is, however, only a few tenth of a millimetre. Much depends on the wear of the teeth and much on the way in which the measurements are taken. I remeasured SCHLOSSER's specimens to be sure that the measurements were comparable with my own.

The dentition of *Gazella dorcadoides* was characterized as follows (1935, p. 92): »Die wichtigsten Merkmale, die diese Zähne von den übrigen Gazellen-Zähnen der chinesischen *Hipparion*-Fauna unterscheiden, sind: die grössere Höhe der Zähne, die ziemlich gleichgrossen oberen Prämolaren; das Fehlen einer Hinterrippe an den oberen Molaren und die entsprechende Konkavität der Aussenwand des Hinten-aussen-Höckers; die platte Innenwand der unteren Molaren und ein im grossen ganzen zierlicher Bau aller Zähne.» Some statements made on p. 91 (l. c.) allow for a certain varia-

tion: upper molars: »zuweilen ist eine schwache Andeutung einer hinteren Rippe besonders an der Basis des Zahnes, vorhanden» »Die Unterkiefermolaren sind hochkronig . . . mit platter Innenwand, an der aber die Rippen und Falten deutlich hervortreten. Die Falten sind gewöhnlich stärker als die Rippen.»

It is necessary to mention in this connection that on the lower molars of *Gazella sp.* (BOHLIN 1935) the ribs (as is evident from the much larger material of lower jaws now at my disposal) are less pronounced and the folds accordingly more conspicuous than in the true *Gazella gaudryi* described and figured by SCHLOSSER, the material from Loc. 73 and other localities (BOHLIN 1935), and most of the material figured by TEILHARD & TRASSAERT in 1938. The extremes of this type come in this regard close to the extremes of *G. dorcadoides,* but there is still the difference in height and above all the upper dentition to be accounted for. I will come back to this further on.

As is seen, my description of the teeth of *Gazella gaudryi* and *Gazella dorcadoides* agrees with that given by SCHLOSSER, but this does not mean that I have mechanically copied SCHLOSSER. In 1934 I visited Munich and studied SCHLOSSER's types comparing them with SCHLOSSER's figures and a rich material of photographs of my own material. I had at that time already been able to determine my own material with the aid of SCHLOSSER's figures, and all that was needed was to make certain that I had understood these figures rightly.

TEILHARD & TRASSAERT's conception (1938 pp. 3—10) of the two species is the following: the fossil Gazelles in their position are distributed »into a number of characteristic, but elastic, groups, expressing the general evolution of the genus». One of this groups is »A Pontian sub-group, well expressed in *Gazella gaudryi* SCHL.» The material referred to this group is treated under 3 headings:

1) *Gazella* (»*Protetraceros*») *gaudryi* SCHL. 1903, to which the material described by TEILHARD & YOUNG in 1931 is supposed to belong. The diagnosis reads: »A *Gazella* of small size, with horn-cores almost straight, slender and well separated from each other on a broad frontal area. Lower P_4 of a primitive type (metaconid widely separated from the paraconid) and relatively brachyodont: paraconid and metaconid diverge slightly upward as in a Y (instead of being parallel as in a U, as it happens in the truly hypsodont forms).» The material figured in 1938 is undoubtedly of the *Gazella gaudryi* type.

2) *Gazella gaudryi* form A. Synonymes: *Gazella gaudryi* BOHLIN 1936 and ?*Gazella dorcadoides* SCHLOSSER 1903 (!). Diagnosis: »A Gazella of the *gaudryi* type, but larger and with more recurved horn-cores.» Also in this case it is no doubt that the determination is correct.

3) *Gazella gaudryi* form B. Supposed to be the same form as the one described by me in 1935 as *Gazella sp.* (*aff. gaudryi*). Regarding this form B I am somewhat doubtful. The upper teeth (l. c. fig. 7) show all the characters of *Gazella dorcadoides:* premolars of about the same length, no rib on the metacone of M^1 and M^2, strongly developed mesostyle (see also below p. 92). This should mean that *G. dorcadoides* also occurs in the red sands of SE Shansi (contrary to the opinion expressed by me in 1935!). If I am right about the upper molars, the lower jaw »tentatively referred» to the same form (l. c. fig. 8) cannot belong together with the upper molars (see below p. 92).

Comparative study of some dentitions of *Gazella gaudryi* and *Gazella dorcadoides.*

The material now available at the Palaeontological institute in Uppsala is of importance, as it comprises series of teeth of both types in exactly the same stage of wear.

1) Upper jaws (Pl. I: fig. 3 *Gazella gaudryi* type, fig. 9 *Gazella dorcadoides* type). DP^4 is still functioning but much worn. The crown of P^4 is fully formed, and the tooth is on the verge of replacing its predecessor. M^1 is rather much worn, the posterior part of M^2 is practically unworn, M^3 is just erupting and its roots have not yet begun to develop. For comparison I have studied a jaw of *Gazella paragutturosa* (Loc. 64, ex. 11), slightly more advanced at least in the eruption of M^3. M^2 has about the same wear as in the other jaws (Pl. I fig. 7).

a) *Gazella gaudryi* type. Comparatively brachyodont. Molar characters as described above. The base of M^2 is already almost on level with the base of M^1 (difference at most 2 mm).

b) *Gazella dorcadoides* type. Comparatively hypselodont. With molar characters as described above. Base of M^2 on a considerably higher level than the base of M^1 (difference at least 5 mm).

Measurements (L_K = Length at the top of the crown; the index gives the relation Length/height × 100):

	P^4	M^1		M^2			M^3		
	H	L_k	H	L_k	H	Index	L_k	H	Index
1 a)	9.5	11.3	8.7	12.7	12.1	105.7	12.1	13.6	89.0
1 b)	12.3	11.7	12.5	14.5	18.8	77.5	15.0	20.1	75.0
G. paragutturosa . .	16.0	15.0	18.6	17.1	>25.0[1]	68.4	16.3	23.6	69.1

[1] Height somewhat worn 24.4.

2) Upper jaws (Pl. I: fig. 2 *Gazella gaudryi* type, fig. 8 *Gazella dorcadoides* type). M^3 fully erupted but posterior part only slightly touched by wear. P^4 somewhat more worn in b) than in a).

a) *Gazella gaudryi* type. The fosettes on M^1 and M^2 are still confluent. A line through the base of the teeth (M^3—P^4) is comparatively slightly arched. Compare the jawfragment of *Cervocerus novorossiae* fig. 1 in the same plate.

b) *Gazella dorcadoides* type. Wear on M^1 considerably better developed than in a). The fossettes are separated and the posterior one is partly obliterated. A line through the base of the teeth is comparatively much arched.

Measurements:

	P^4			M^1			M^2			M^3		
	L_k	H	Index	L_k	H	Index	L_k	H	Index	L	H	Index
2 a)	6.9	10.2	67.6	10.7	9.0	118.9	11.8	10.7	110.3	11.7	12.9	90.7
2 b)	7.1	11.9	59.7	?11	11	100	13.5	15.3	88.2	11.8	16.5	72.1

In both these cases the jaw of the *Gazella dorcadoides* type has a longer series of molars than the other (M^1—M^3 1 a) 33.8, 1 b) 38.3; 2 a) 32.3, 2 b) 34.3). This does, however, not account for the considerable difference in height, as is clearly seen from the indices. Moreover the length at the neck of the tooth on level with the upper border of the enamel on the outer side is practically the same (except in the first case in M^3; the one of 1 b) is much longer at the base than at the top of the crown, whereas in 1 a) the anterior and the posterior margin of the outer side are parallel), for instance for M^2: 1 a) 9.7, 1 b) 9.8, 2 a) 9.3, 2 b) 9.2. As is seen from a comparison between the figures, the molars of the *Gazella dorcadoides* type are more pinched at the base than those of the *Gazella gaudryi* type. Further, the roots of M^2 (closed in the specimens figured in Pl. I figs. 2 and 8) are in the *Gazella dorcadoides* type shorter than half the height of the crown, whereas in the *Gazella gaudryi* type they are only little shorter than the entire height of the crown (the figured teeth are worn, but the wear is in both cases the same).

It is not only a matter of taste, if the teeth of the *Gazella dorcadoides* type shall be called hypselodont or not. In my opinion they already have the stamp of hypselodonty impressed upon them, and the show a distinct advance in the direction of the still greater hypselodonty found in the Middle Pliocene and early Pleistocene forms (compare, however, p. 87). Only this character would suffice to distinguish *G. dorcadoides* from *G. gaudryi*. Also *G. gaudryi* has, however, rather high-crowned teeth, but it can at most be called semihypselodont, as the whole appearance of the

upper dentition comes very close to the brachyodont *Cervocerus novorossiae* (Pl. I, figs. 1 and 2).

For some M^2 of the *Gazella gaudryi* type the following indices were computed (somewhat worn specimens in brackets): Loc. 49 (102.1); Loc. 73 103.3, 106.0; Loc. 78 (115.5); Loc. 114 S = 1 a) above (105.7). For the *Gazella dorcadoides* type: Loc. 30 (70.5), 76.1, 76.4, 77.5, (78.6), (79.5), (86.7)[1]; Loc. 114 S 80.9.

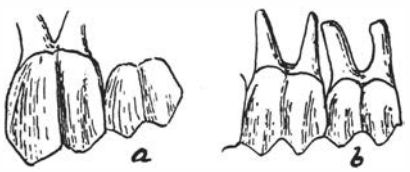


Fig. 1 A. M^1 and M^2 a. ?*Gazella dorcadoides* type, see below, b. = Pl. I, fig. 2, natural size.

Further, I have computed a series of indices for the M^2 of various species (M^2 not or only very slightly worn; P^4 fully formed but not yet erupted):

		Difference
Cervocerus novorossiae KHOMENKO (Loc. 35)	128.3	22.6
Gazella gaudryi type (1 a above, Loc. 114 S)	105.7	2.4
Gazella gaudryi (Loc. 73; from the list above)	103.3	25.8
Gazella dorcadoides type (1 b above, Loc. 30 or 109) . . .	77.5	4.2
Gazella kueitensis[2]	72.3	3.9
Gazella paragutturosa (Loc. 64)	68.4	8.4
Bovine sp. (BOHLIN 1938, Pl. XI: 4)	60.0	

(This latter tooth is comparatively more worn than the others).

3) In my new material there is a number of upper milk dentitions, which together with those known before make a comparative study possible. I have in all 10 specimens of the *G. dorcadoides* type (of these three with the teeth of both sides) and 6 of the *G. gaudryi* type (one with the teeth of both sides). SCHLOSSER knew the upper milk teeth only of *Gazella*

[1] From a very crushed fragment of a skull with the attached lower jaws (also fragmentary). The molars are rather well preserved and remarkably low-crowned. The milk molars are still present and evidently much worn. The whole series of molars is, except for the lesser height of the teeth, very similar to the ones in Pl. I: 9 — there is no rib on the outer side of the metacone, the mesostyle is strong, the crown is distinctly pinched at the base, and the roots are short, divergent and closely approached to each other (see fig. 1 A). The crown of the M^3 (left side) is not yet fully formed (height of the enamel 13 mm); M^2 (right) L_k 13.0, H 15.0; M^1 (left) L_k 11.8, H 10.0. The DP^4 seems to be about as much worn as the one in the jaw, Pl. I: 9, but I have not been able to find any trace of the P^4 above it. The skull fragment is too crushed to show any details of importance. In the lower jaw the M^2 is also remarkably low: L_k 13.0, H 15 +, Index < 86.7. In spite of its low molars this fragment must at present be referred to the *Gazella dorcadoides* type.

[2] Probably = *G. blacki* TEILHARD & YOUNG (see below). Ex. D, see p. 10, BOHLIN 1938. The height of M^2 was measured on the opposite side, *not* on the same side as the length of DP^2—DP^4 as was stated in 1938.

gaudryi (the DP^3 and DP^4 figured in Pl. XI: 21); his description only comprises two characters (l. c. p. 137): »Von den beiden noch vorhandenen Milchzähnen trägt der hintere — D^4 — im Gegensatz zu den Molaren einen Basalpfeiler, an dem vorderen — D^3 — ist der erste Innenmond von dem zweiten schon nicht mehr so scharf abgesetzt wie bei den Cerviden.» Of these characters the first one seems to distinguish *G. gaudryi* from *G. dorcadoides;* the second is common to both as could be expected. For the rest the milkteeth of the two types differ in a similar way as the true molars. In both types the ribs on the metacone is heavier than on the molars, i. e. in *G. dorcadoides* there is a distinct rib on the metacone of DP^4 and a somewhat stronger one on DP^3; in *G. gaudryi* these ribs are very heavy, especially on DP^3, where the whole outer side of the metacone is strongly convex. The anterior rib on DP^3 and DP^4 is also much heavier in *G. gaudryi* than in *G. dorcadoides.* On the DP^3 of the latter type this rib is thin but prominent, and on most of the specimens distinctly folded over forwards, so that the slit between the rib and the anterior fold is very narrow and deep. In *G. gaudryi* the same slit is also rather deep but much wider. On some of the teeth of the *Gazella gaudryi* type there is a swelling at the base, which in a fragment from Loc. 78 forms a distinct cingulum on the inner side of DP^3 and DP^4 and on the posterior part of the outer side of DP^2. Slight basal swellings can occur also in the *G. dorcadoides* type. In general the same rule is valid as for the rest of the dentition, namely that the milk teeth of the *G. dorcadoides* type are of a more delicate structure.

On the teeth figured by SCHLOSSER the mesostyle is perhaps slightly more pronounced than on the DP^3—DP^4 of *G. gaudryi* among my material. The same is true about the valley between protocone and hypocone with one exception, a skull from Loc. 73.

A series of milk teeth of *Gazella gaudryi* was figured in 1935 (Pl. X: 9). These teeth are refigured here for comparison (fig. 11; the outer side has been prepared to a somewhat greater extent than in 1935).

Measurements (average of whole material, number of specimens in each case in brackets):

	DP^2			DP^3			DP^4				DP^2—DP^4
	L_k	Min.	Max.	L_k	Min.	Max.	L_k	Min.	Max.	H	L_k
G. gaudr.	(4) 8.0	8.0	8.0	(5) 9.5	9.0	10.1	(6) 9.8	9.1	10.1	(6) 5.6	(4) 26.0
G. dorc.	(6) 7.1	6.3	7.7	(10) 8.6	7.9	? 9.0	(10) 10.1	9.0	10.9	(9) 7.0	(6) 25.7

The upper milk dentition of the two types is of about the same size. The average length for the separate teeth shows that in the *G. gaudryi*

type DP^2 and DP^3 are slightly more elongated in comparison with DP^4 than in the *G. dorcadoides* type, which agrees with the relative length of the premolars. The material is small, and the difference might be accidental. I can mention that the maximum for DP^2 of the *Gazella dorcadoides* type is associated with a DP^4 of 10.6 mm length. There are no unworn milk teeth, but in cases when jaws of both types, in which M^1 and M^2 show the same amount of wear, are present, the milk teeth of the *G. dorcadoides* type are distinctly higher. The average for the height of DP^4 points in the same direction, and it may have some value, as the material of both types seems to have on an average the same wear.

4) Lower jaws (Pl. I, fig. 5 *Gazella gaudryi* type, fig. 6 *Gazella dorcadoides* type. Both from Loc. 49). The material of the *G. dorcadoides* type is fairly large, but there are very few jaws with the complete series of premolars and molars. I have had to figure a jaw, in which M_3 is already much worn (also the hypoconulid) and the other molars in a very advanced stage of wear, for comparison with a jaw of the other type, in which M_3 is almost unworn and the other teeth moderately worn (compare P_4 in figs. 11 and 13). The lower jaw of the *Gazella dorcadoides* type figured in 1935 (loc. 43, ex. 1; Pl. XII: 15) has an unworn M_3, the measurements for the teeth of this jaw have been entered in the table below (the base of the molars was not exposed in 1935). Further, measurements for a jaw from Loc. 114 S (? *Gazella sp.* BOHLIN 1935) are given:

	P_2		P_3		P_4		M_1		M_2		M_3		P_2—M_3	P_2—P_4	M_1—M_3
	L	H	L_k	H	L_k	H	L_k	H	L_k	H	L_k	H	L_k	L_k	L_k
Loc. 43	5.5	4.9	7.0	7.1+	8.7	7.9+	10.2	9.8+	12.2	15.1+	(15.5)	18.8	56.8	20.9	37.4
Loc. 49 (Pl. I: 6)	4.7	6+	7.5	7 +	8.5	8 +	9.6	7.1+	11.7	12.5+	18.2	18.7+	59.0	20.1	39.3
Loc. 114S (Pl. II: 1)	—	—	—	—	8.8	7.9+	9.6	8.6+	13.1	13.9+	(17.0)	16.1+	62	23	39.4
Loc. 49 (Pl. I: 5)	5.1	4	7.2	6	9.0	7 +	9.2	5.4+	11.0	9.1+	15.2	11.7+	55.5	21.0	35.0

Index $L_k/H \times 100$ for some M_3: *Cervocerus novorossiae* 179.3; *Gazella gaudryi* (Pl. I, fig. 5) 129.9, unworn M_3 (loc. 49) 119.4; Loc. 114 S (same specimen as in the table above; slightly worn) 105.6, for two unworn M_3 from the same locality 101.3 and 98.7 (the second of these probably belongs to the very small form of the *Gazella dorcadoides* type occurring at Loc. 114 S; the structure of the teeth (Pl. II, fig. 5) is namely quite different from that of the teeth referred to the *Gazella gaudryi* type, and especially the M_2 is a very high and slender tooth — index for the already much worn M_2 85.7; in the other jaw the M_2 is considerably less worn and has an index of 96.4; see below); *Gazella dorcadoides*: Loc. 49 (Pl. I, fig. 6; much worn, see table) 97.4, Loc. 43 (unworn) 82.4, Loc. 30 (unworn) 82.5;

Gazella paragutturosa (somewhat worn) 83.4. The only thing that with certainty can be inferred from these indices (compare also the tables of measurements on pp. 95 and 102) is that also the *Gazella gaudryi* type has advanced very far from a truly brachyodont condition. Because of the rather variable complications found on the posterior side of the hypoconulid and, evidently, also frequently occurring enamel deficiencies at the base of the tooth, the index for M_3 does not seem to provide a reliable base for a distinction between the *G. gaudryi* type and the *G. dorcadoides* type. One possible way would perhaps be to exclude the hypoconulid when measuring the length of M_3, but the limit between the metaconid and the hypoconulid is very often hard to state even on unworn specimens. — Of M_2 I have measured all the unworn or very little worn specimens, I have been able to get hold of (associated with milkteeth, if any teeth at all in front of the molars were preserved) and stated for 9 specimens of each type the following variation: *Gazella gaudryi* type: Index $L_k/H \times 100$: 90.8—104.5 (Loc. 29 92.1; Loc. 48 104.5; Loc. 73 90.8—100; Loc. 78 104.5; Loc. 114 S 95.0—101.6). *Gazella dorcadoides* type: Same index: 69.7—73.9 (Loc. 30 69.7—73.8; Loc. 109 73.9; Loc. 114 S 72.7). The difference between the minimum of the first type and the maximum of the second one amounts to very nearly 17 units (see, however, note 1 on p. 87). Some of these indices for M_2 will be found in the tables of measurements below.

Of the two jaws figured the one of the *Gazella dorcadoides* type is, as already mentioned, in a distinctly more advanced stage of wear than the other. M_1 is still somewhat higher, but there is no trace of the fossettes, whereas in the second jaw they are still large. In one jaw of the *G. gaudryi* type, with M_1 of the same height as in the one figured, there is only a small rest of the posterior fossette visible, the anterior one is just deleted. In most cases both fossettes are still preserved, even at a somewhat more advanced stage of wear. In a jaw of the *G. dorcadoides* type (Loc. 30_5) the last traces of the fossettes are seen on a M_1 10 mm in height. Also on M_2 (and on M_3?) the fossettes disappear at an early stage of wear, for instance: in a jaw fragment from Loc. 30_5 the last traces are seen on a tooth 10 mm in height; in another jaw from the same locality the M_2 is of the same height, but the fossettes have entirely disappeared; in a third jaw there are traces of them on a M_2 9 mm in height. In a jaw of the *G. gaudryi* type from Loc. 78 a rest of the anterior fossette is still seen on a M_2 with a height of 4 mm; in a jaw of the same type from Loc. 49 M_2 is 7 mm high, the anterior fossette is large indeed, and it can be stated by direct measuring that it will stand the wear for at least 3 more millimetres. In the jaw from Loc. 114 S (see the table above) M_1 has large fossettes, which do not show any tendency to disappear.

As in the upper jaws there is a difference between the two types in

the way the teeth erupt. In the *G. dorcadoides* type the base of the M_3 is still deep in the jaw when the crown of M_1 is fully erupted, whereas in the *G. gaudryi* type the base of the three molars are much more on the same level. In the *Gazella dorcadoides* type the base of the M_3 has not appeared above the edge of the jaw, even when the crown of M_1 is entirely worn out.

5) The lower milk dentition of both types is also known. The one of the *G. gaudryi* type was figured in 1935; of the *G. dorcadoides* type I then figured only the DP_4 (the only one present in the material at that time). It seems from a study of the material now available (4 or 5 specimens of each type), as if the basal pillars on the teeth of *Gazella gaudryi* type were in general heavier than in the other, in which they sometimes are missing (always present in the *Gazella gaudryi* type?).

The evidence produced above is found already in my paper of 1935, although I did not think it necessary to discuss it at such length. I can refer to the tables of measurements (pp. 100—105) and to the text (pp. 91—92 where I also refer to the tables). How the measurements were taken was explained on pp. 5 and 6; — the length of the lower molars were measured according to a method proposed by ZDANSKY in 1925 (»Fossile Hirsche Chinas»). In the present paper I have measured the length of the lower molars at the wear surface, which is correct if, as in this case, jaws in the same stage of wear are compared. SCHLOSSER has measured in the same way, and this explains the great discrepancy between my measurements (1935) and those of SCHLOSSER in the case of *Gazella dorcadoides:* for example in my table on p. 105 (1935) the length of M_1 and M_2 (Loc. 109, ex. 7) would be 12.5 or 15.0 respectively. I also want to refer to my Pl. XI, figs. 6—9 and XII, figs. 21—22 and others, which show the difference in height of the teeth of the two types in the same way as the figures of the new material in the present paper.

I have now come to the point, when it is possible to explain, why I did not accept the diagnosis of TEILHARD & YOUNG in their paper of 1931 (compare p. 83). The description given by TEILHARD & YOUNG runs (l. c. p. 35): »The chief characters of the species referred here tentatively to the rather uncertain *G. gaudryi* are as follows: 1) Teeth of the primitive *Gazella* type: premolars brachyodonts, and last premolar of the 'simple type' (metaconid not flattened, nor fused with a posterior flange of the paraconid). (Text fig. 4.) 2) Horn-cores small, slender and straight.» If TEILHARD & YOUNG had instead made a careful comparison of their specimens with *G. dorcadoides* as described and figured by SCHLOSSER, they would have found that the teeth figured by them agree with the type material in having a very flattened inner wall on the molars. To judge

from the drawings and photographs reproduced (l. c. Text fig. 4 and Pl. VII, figs. 5 & 6) the lower molars are rather high; M_1 is evidently fully erupted in at least one of the jaws (notice the basal pillar in Pl. VII, fig. 6) but still quite high, and, as is seen in Text fig. 4 a, there is no trace of the fossettes. Exactly how high M_2 is cannot be told from the figures, but it must be higher (and, as it seems, rather much higher) than the M_1. The fossettes on this tooth have shrunk to small compressed ovals occupying only a small part of the length of the tooth. A comparison of these teeth with the ones figured by TEILHARD & TRASSAERT in 1938 shows that these latter are of quite another type: the M_1 is evidently lower than in the jaws figured in 1931, and yet it has well developed fossettes, almost as large as on M_2, and the inner wall has a very marked relief. The teeth figured in 1931 are undoubtedly of the *Gazella dorcadoides* type, as I have pointed out in 1935 (p. 92). I have copied parts of TEILHARD & YOUNG's text fig. 4 a and reproduce them here together with the corresponding teeth of some jaws in my own material (these jaws were the first I got hold of and are not chosen to show any extremes, or they were chosen for other purposes and used because they were at hand; they can thus be said to be good average representatives for the two types originally distinguished by SCHLOSSER). In 1931 also some upper molars and one upper premolar are figured (Pl. VII, figs. 7 & 8). It can hardly be any doubt that on all the molars (where the crown has not been destroyed by wear) the rib on the metacone is lacking and that the outer surface of this cusp is concave. As gazelles of the *dorcadoides* type are common at the Paote localities and, as it seems from my material, even dominating at some of them, my determination is quite reasonable.

I have already stated above that the material referred by TEILHARD & TRASSAERT (1938) to a form, which I in 1935 described as *Gazella sp.* (aff. *gaudryi*), evidently is heterogeneous. Fig. 7 shows the upper dentition with all the premolars of about the same length (compare figs. 3 & 6 in the same paper, in which the anterior premolars are distinctly longer than the P^4). The premolars are quite well worn, but yet at least as high as the almost unworn premolars in figs. 3 & 6. The outer side of the metacone of the molars is deeply concave and lacks a rib on M^1 and M^2; on M^3 a rib is evidently present (compare BOHLIN 1935, p. 91; M^3 seems to be the tooth, on which such a rib occurs most frequently). The lower jaw (l. c. text fig. 8) is »tentatively referred», and I can say for certain that it cannot belong to the same species as the upper teeth figured in text fig. 7. The M_1 is at least not higher than in the jaws figured by TEILHARD & YOUNG in 1931, and the fossettes are still large.

In their historical review (1938 pp. 2 & 3) TEILHARD & TRASSAERT state that »we are faced with the unfortunate fact that the first fossil forms of *Gazella* have been named and described mainly by Schlosser, using

utterly insufficient specimens. Later (in 1935) Dr. Bohlin . . . tried to make the best of this situation. But he was confronted with an impossible task.» In my opinion it was not at all unfortunate that SCHLOSSER got the first word on the Chinese fossil gazelles, and it was not unfortunate either that the material at his disposal consisted only of a few jaw fragments and teeth. SCHLOSSER had a keen eye for form, and a more complete material might have distracted his attention from the detailed study of the teeth, the result of which must be, as far as I can see, on the whole correct. SCHLOSSER was confronted with a seemingly hopeless task, but as far as my experience of SCHLOSSERS »Die fossilen Säugethiere Chinas» goes, he has succeeded remarkably well. The part on the gazelles is no exception. As to myself, I have only had to follow SCHLOSSER, and as far as SCHLOSSER could be followed, namely to the distinction of two types of dentitions, the *gaudryi* and the *dorcadoides* types, my task has not been extremely difficult. The difficulties set in, when it comes to the entangling of the variety of form encountered within the limits of SCHLOSSER's two »species». And to increase the chances to overcome these difficulties a great number of characters — not only the horn-cores and the P_4 (I am almost inclined to say that the less of the P_4 the better, as P_4 has proved to be a rather variable tooth; see figs. 1—8) — have to be taken into consideration and tested. PILGRIM has, for instance, in his paper (1937) paid much attention to the basis cranii, and I have in my descriptions in 1935 included a paragraph on this part of the skull. It is, of course, not sure that the solution of the problem will be found along this or any other single line. Different lines have however to be followed, if they prove impracticable, they will of course have to be abandoned, but even a negative result may have its value. And as important material is scattered all round the world and only a small part is accessible to each student without expensive and time-vasting travel, it is necessary to agree upon a uniform method for the investigation, so that the descriptions will be comparable.

Description of new material.

In the description of the new material I will as far as possible keep the material from different localities apart in the same way as in 1935. Only SCHLOSSER's species names will be used as headings, and I, therefore, include under »*G. gaudryi*» also material of the type formerly described as *Gazella sp.* (= all the new material of this type except that from Loc. 49).

Dentition of *Gazella gaudryi* type.

Loc. 30: Only one lower jaw fragment was added to the very poor material known before. $L_k M_1$—M_3 35.0 (L_b = 40.0). $M_3 L_k$ 15.0, L_b 17.5,


1.
Loc. 30
2.
Loc. 49
3.
4.
5.
6.
Loc. 114 N
7.
9.
10.
11.
12.a
13.a
14.a
15.

H 12.6 (max. ? 14), Index $L_k/H = 119.0$ (? 107.1). P_4 is rather complicated (fig. 1), the molars are of the true *G. gaudryi* type, with thick ribs on the inner side. Another lower jaw from the same locality (1935, Loc. 30, ex. 1) has very nearly the same type of P_4, but the M_3 (almost unworn) is considerably higher and the inner side of the molars have more delicate ribs (compare p. 106). L_k M_1—M_3 37 ($L_b = 40$); M_2 L_k 12.5, H (almost unworn) 12.5; M_3 L_k 16.8, L_b 16.8, H 15.7 (? 16), Index 107.0 (? 105.0). — The L_k/H index for the M^3 (1935, Pl. XII: 2, unworn) is 93.4.

In 1935 (p. 103) I gave the measurements for DP_4 and M_1 (Loc. 30, ex. 2). These compare with the somewhat more worn DP_4—M_1 (and M_2 unworn) of a jaw of the *G. dorcadoides* type (Loc. 30) and a jaw of the *G. gaudryi* type from Loc. 48 in the same stage of wear as follows:

	DP_4		M_1			M_2		
	L_k	H	L_k	H	Index	L_k	H	Index
G. gaudryi (Loc. 48)	—	6	10.8	10.0	108.0	12.8	14.0	91.4
» (Loc. 30)	12.8	6	11.0	11.9+	92.4	—	—	—
G. dorcadoides (Loc. 30) . .	12.4	5.5	11.4	13.8+	81.9	13.7	19.2	71.4

The index for the M_3 from Loc. 31 (1935, Pl. XII: 5) is 112.0 (almost unworn).

Loc. 44: A skull fragment with P^4—M^3 (figs. 16 & 17). A great part of the nasals is preserved and the sutures of the lachrymals can be traced on one side. The fragment thus shows parts, which are damaged in the skull figured in 1935 (Pl. XI: 19 and XII: 1). The surface of the nasals is strongly convex transversally (the fragment may be slightly compressed, but the palate shows no trace of this deformation, and most of the convexity of the nasals is probably natural). The sides of the nasals are parallel and bent down to the same amount as in the skull fragment from Loc. 43 (1935, p. 89). They are not broader in the region of the ethmoidal fissures. These extend backwards beyond the nasofrontal suture. For the sutures

Figs. 1—8. Crown and inner views of P_4. All from jaws of the *Gazella gaudryi* type (compare the text). — Fig. 1. Loc. 30. — Figs. 3—5. Four different P_4 from Loc. 49 (fig. 5 = BOHLIN 1935, Pl. XI: 18). — Figs. 6—8. Three different P_4 from Loc. 114 N (fig. 7 = BOHLIN 1935, Pl. XII: 6 & 7).
Figs. 9 & 10. Part of the lower dentition of two jaws of the *Gazella gaudryi* type. Loc. 49. Crown view.
Fig. 11. Same jaw as is Pl. I, fig. 5. P_4 and M_2, crown and inner views. *Gazella gaudryi* type. Loc. 49.
Fig. 12. *Gazella gaudryi* Loc. 73. P_4 and M_2, crown and inner views. Same jaw as BOHLIN 1935, Pl. X: 11 & 12.
Figs. 13 & 14. Same jaw as in Pl. I, fig. 6. P_4 and M_2, crown and inner views. *Gazella dorcadoides* type. Loc. 49.
Fig. 15. After TEILHARD & YOUNG 1931, text fig. 4 a. P_4 and M_2, crown and inner views.
Figs. 1—15 all 2 × natural size.

see the figures. Length of M^1—M^3 32.5; P^4 L 6.6, H 9.5 (unworn), Index 69.5; M^3 L 11.8, H 12.4 (almost unworn), Index 95.2. — Lower jaw from the same locality (old material): M_3 L_k 16.2, H (almost unworn) 14.5 (? 15.5), Index 111.7 (? 104.5). This jaw is undoubtedly of the *Gazella gaudryi* type and its size agrees well with the skulls. The P_4 resembles the one in fig. 4, but the slit between the paraconid and metaconid is somewhat wider. There is no trace of an accessory cusp at its base.

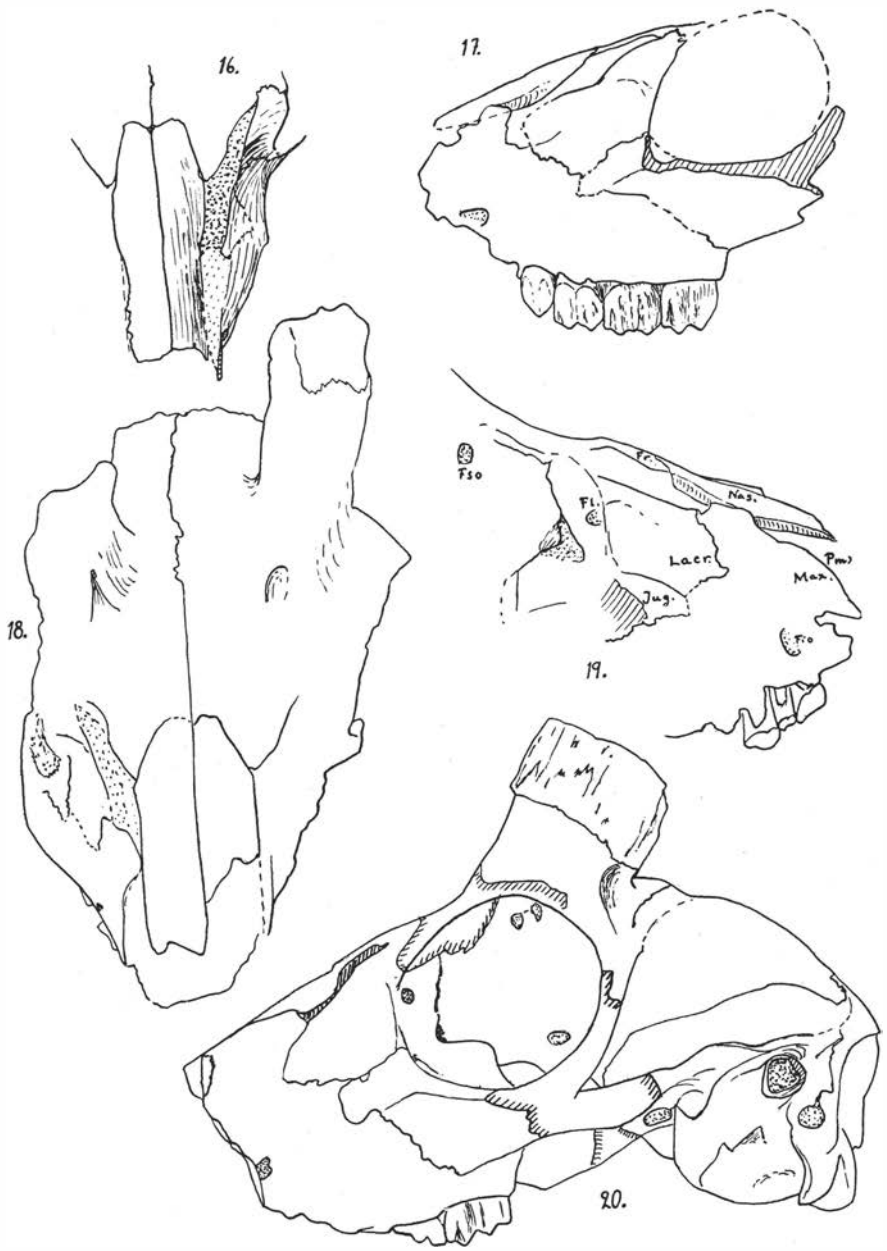
Loc. 49: Several new fragments. Of four series of upper molars, all less worn than the one figured in 1935 (Pl. X: 13), one is somewhat longer (M^1—M^3 33.5), the others somewhat shorter (M^1—M^3 31—31.6) than this but else of the same structure. — For some M_3, not or only slightly worn, the index L_k/H is (figures in brackets with the maximum correction for wear): 119.4; 130.8 (120.8); 130.8 (117.5) = Loc. 49, ex. 3, 1935; 129.9 (121.6). The M_3 from Loc. 48 (1935, Pl. XI: 8) has an index 108.3 and is thus comparatively high. — P_4 (in all 8 specimens): The simplest P_4 has the same structure as most of the P_4 from Loc. 73 (see 1935), with the metaconid shaped as a backwards directed wing. On other specimens the front part of the metaconid is produced forwards and approaching the paraconid, and finally the space between the two cusps is to a great extent filled up by an accessory cusp coming up from the base (present on most of the specimens). The metaconid is, however, not detached from the protoconid even in this most advanced type. The specimens in figs. 2—5 show the gradual transgression from the simplest to the most complicated type (compare also the P_4 in figs. 9—11, which are from the same locality).

Loc. 114 S: The new material from this locality comprises several skulls, skull fragments and lower jaws. The skulls are distinctly of two types.

A.

A larger type is represented by only one skull (figs. 20 & 24). Of the teeth only M^2 and M^3 on both sides are present (left M^2 damaged); of P^3—M^1 only the roots; the muzzle is broken off in front of the P^3. For the rest the skull is beautifully preserved and only slightly crushed (of the rim of the orbits enough is present to allow a reliable reconstruction).

The condyles are fairly large, their posterior surface is almost in the same plane as the occiput. The posterior tuberosities on the basis cranii are heavy but clearly sharp-edged, and they join forwards to a wedge extending into the deep, but at the bottom narrow, groove between the tubercula pharyngea as far as to the anterior one-third of the bullae. Between the two pairs of tuberosities the sides of the basioccipital are concave and face outwards and downwards, and there is a distinct widening at the tubercula pharyngea. These latter form heavy prominent swellings. The bullae are large and extend far in front of the apex of the tubercula pharyngea (fig. 48).



Figs. 16 & 17. *Gazella sp.* Skull fragment: top and left side views. Loc. 44.
Figs. 18 & 19. *Gazella sp.* Skull fragment, top view and lateral views (premolars abnormal). Loc. 43.
Fig. 20. *Gazella sp.* Skull: lateral view. Loc. 114 S, »large».
Figs. 16—20 two-third natural size.

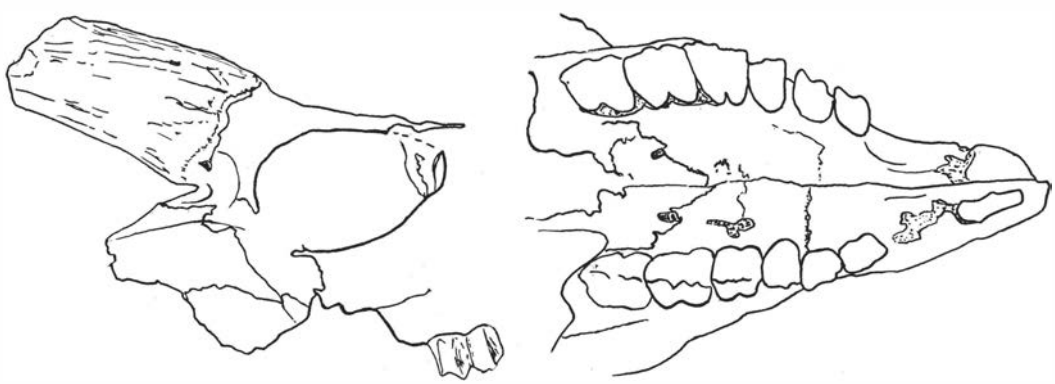
The occiput is large and the mastoids occupy a comparatively large part of its surface. As a whole the brain case is large and capacious. The suture between the frontals is raised into a strong ridge, and also the fronto-parietal suture is rather thick. The orbits are large and resemble most those of a female skull from Loc. 44 (1935 Pl. XI: 19). The nasals are fitted into shallow recesses in the anterior end of the frontals. The suture is M-shaped, and the median lobe is almost as prominent as the side lobes. The lateral borders of the nasals are parallel to the point, where the bones are broken off (length of the fragments 45 mm; breadth at the ethmoidal fissures 12 + 11.5 mm; in this region the nasals are possibly a little wider than between the maxillae). The upper surface is medially flattened, laterally convex, the edges are covered by the maxillae. The ethmoidal fissures extend backwards far beyond the naso-frontal suture (compare the specimens from Loc. 43 (fig. 18) and 44; in these the lateral lobes of the frontals are much larger — ? with exception of the female skull from Loc. 44). The lachrymals are large, their anterior end reaches at least above the last premolar. The excavation in the maxillae for the premaxillae is partly preserved on both sides (see fig. 20).

Of the horn-cores only the basal part and the pedicles are preserved. The cross section at the base is elongated (in all regards very similar to the one figured in 1935, Textfig. 73 e).

The teeth preserved are of the *Gazella gaudryi* type.

B.

Of a smaller type I have three fragmentary skulls (two males and one female) and five skull fragments, in which parts of importance for the knowledge of the skull are preserved. Further there are several palates and upper jaws with the teeth and a great number of lower jaws. The skull material is by far not as well preserved as the larger skull described above,



Figs. 21 & 22. *Gazella sp.* Skull fragment. Fig. 21. Part of horn-core and orbit, lateral view. Fig. 22. Palate. — Loc. 114 N. Two-third natural size.

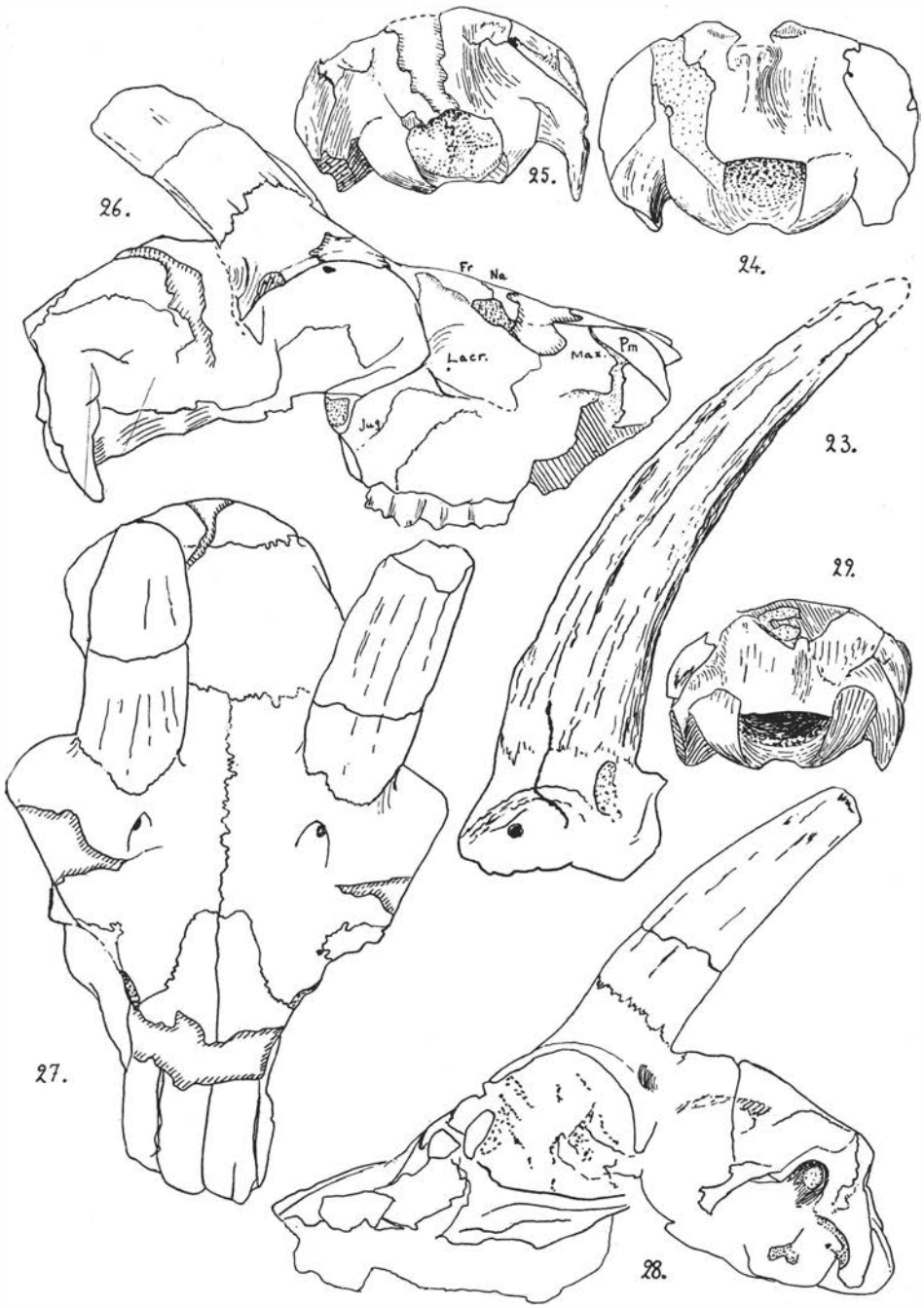
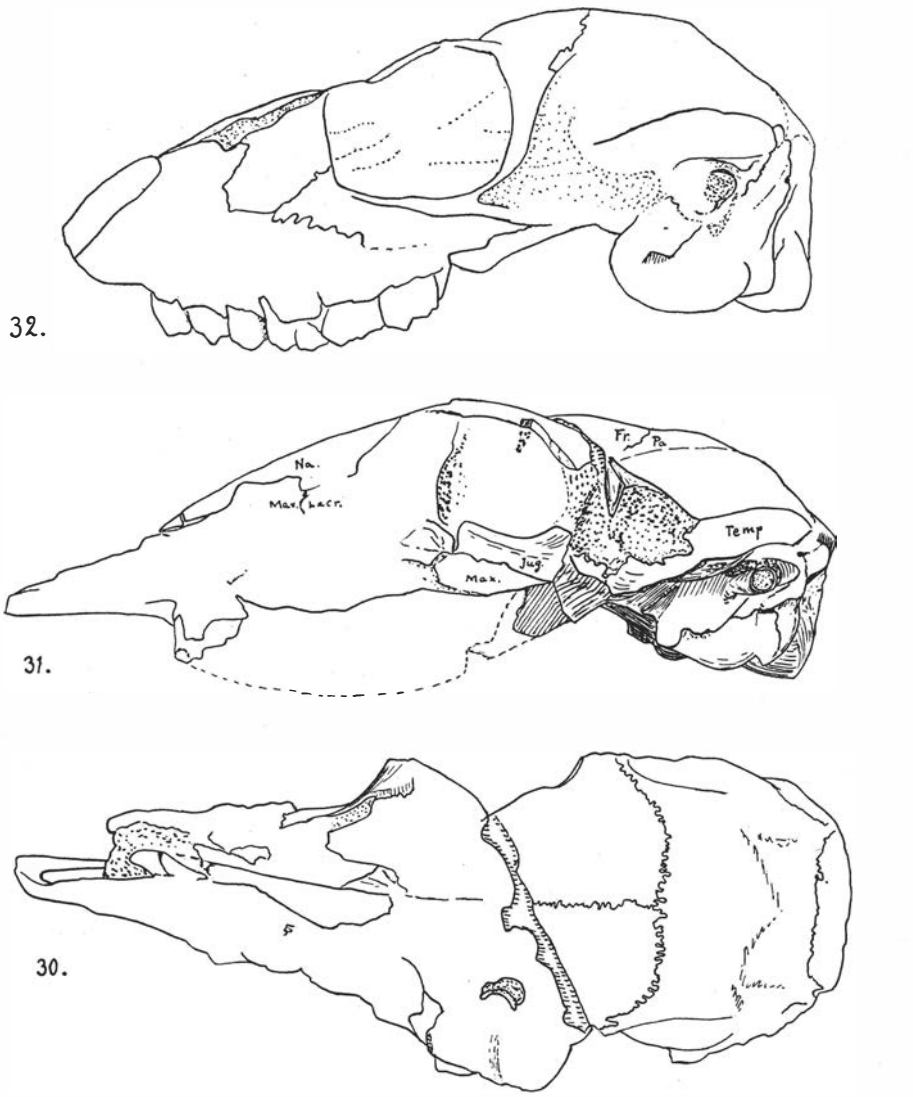


Fig. 23. *Gazella sp.* Left horn-core, lateral view. Loc. 114 N.
Fig. 24. *Gazella sp.* Occiput of the skull in fig. 20.
Figs. 25—27. *Gazella.* Skull: occipital, lateral and top views. Loc. 114 S, »small».
Fig. 28. *Gazella.* Skull: lateral view. Loc. 114 S, »small».
Fig. 29. *Gazella.* Occiput of the skull in fig. 30.
Figs. 23—29 two-third natural size.

and the teeth of the more complete skulls are absent or in a very poor condition (figs. 29—31, 42, 43).

The condyli are like those of the large skull and almost as large, although the brain case is much slenderer. In two of the skulls (the female skull and one of the male skulls, both old) the inferior side of the basi-occipitale is flattened, and the concave surfaces between the two pairs of tuberosities face more downwards than in the larger skull. The basis is tapering regularily from the posterior tuberosities to the presphenoid, and thus there is no widening in the region of the tubercula pharyngea. These form comparatively small rounded knobs, closely approached to each other, but separated by a shallow but distinct groove. The third skull (a male without teeth) was split along the basis cranii and this is rather damaged, but it is evident that in this skull the tubercula pharyngea were very well developed and probably »wing like» as in a skull of *Gazella ?altidens* (*dorcadoides* type, see fig. 50) and connected with the posterior tuberosities with prominent ridges in the same way as in this skull. The surfaces laterally to these ridges face downwards as in the other two skulls. The bullae osseae are very small and compressed laterally, their anterior end is almost on level with the apex of the tubercula pharyngea. Both bullae are missing in one of the skulls, but the short distance between the foramen lacerum posterius and the foramen ovale shows clearly that the bullae have been small also in this case. The skulls from Loc. 73, Wu-hsiang-hsien and Loc. 70, all described and figured in 1935 as *Gazella gaudryi*, resemble the larger skull in the structure and the size of the bullae; also the basis cranii is more like the larger type, although it is flatter.

The occiput is smaller than in the larger skull, partly due to the much smaller area occupied by the mastoids (compare figs. 25 and 29 with fig. 24). The whole brain case is smaller (see fig. 51 a—c and the table on p. 120): the height is considerably smaller, although the breadth in both cases is the same. The suture between the frontals is very inconspicuous, and the fronto-parietal suture is in the same plane as the surface of the surrounding bones. The orbits are small and of about the same size in the six specimens, in which they are at least partly preserved. The posterior ends of the nasals are embraced by large lobes of the frontals. The posterior end of the ethmoidal fissures lies in front of the most posterior point on the naso-frontal suture. The portion of the nasals bordering on the ethmoidal fissures is considerably broader than the portion in contact with the maxillae and the premaxillae (in the best preserved skull 30 mm or 20 mm respectively). The free end of the nasals is blunt (see fig. 27; length of the nasals 62 mm). The lachrymals are relatively of the same size as in the large skull and have the same extension forwards. The horn-cores are much smaller than in the larger skull. The ones in fig. 28



Figs. 30 & 31. *Gazella.* Female skull: top and lateral views. Loc. 114 S, »small».
Fig. 32. *Gazella gaudryi* Loc. 73. Female skull: lateral view. Same as BOHLIN 1935, text figs. 56 & 57.
Figs. 30—32 two-third natural size.

belong to a rather crushed skull, but the relation between the horn and the frontal seems to have been only slightly influenced. The cross-section seems to be somewhat more rounded than in the larger skull (the outer side is more flattened but the inner side more convex).

In the table of measurements on p. 120 the somewhat smaller size of these skulls, the much smaller bullae, the smaller orbits and the lesser height of the brain case as compared with the larger skull come forth.

As already mentioned, the teeth of the more complete skulls are missing or in a very bad condition. In the best preserved skull M^1—M^3 on the right side and M^2—M^3 on the left side are present. On M^1 about 1 ½ mm of the height of the crown remains and on M^3 about 4 mm, this latter tooth is fully erupted. In a skull fragment, with certainty belonging to the *G. dorcadoides* type, with the same amount of wear on the M^1, the M^3 is still nearly 9 mm high and its base is hidden in the jaw (an M^3 of 9 mm height of the *G. gaudryi* type corresponds to an only half worn dentition: M^1 for instance about 5 mm high and still with large fossettes on the wear surface). A skull fragment with exactly the same osteological characters as the skulls described above (naso-frontal suture, ethmoidal fissures, size of the orbits, extension of the lachrymals the same) has a dentition distinctly of the *Gazella gaudryi* type (long anterior premolars) and there are still five less well preserved fragments with the complete series of upper teeth. The length of P^2—M^3 varies between 51—55.2 mm (in one case, where P^2—M^3 is only 49.5 mm, the P^3 is transversally placed). The length of the M^2—M^3 of the larger skull is 25.3, the same measurement for the longest series of teeth of the smaller type is 22.3.

To the two best of the smaller skull fragments both lower jaws are attached. Length P_2—M_3 52 mm, 56.3 mm (P^2—M^3 51 mm, 54.5 mm). In some other lower jaws P_2—M_3 are preserved. The size of these fits partly well with the smaller skulls (variation between 55 and 57 mm — the measurements are partly approximate); in one jaw — the length of P_3—M_3 is 57.3 mm, the length of P_2—M_3 would in this case have been 62 or 63 mm. This jaw and a couple of other fragments are evidently of the size of the larger skull.

The lower molars from Loc. 114 S are perhaps somewhat higher than the average of the teeth from Loc. 73, 78 and others, but they are much lower than the teeth referred to *Gazella dorcadoides* and related forms as seen in the following table (M_2 unworn or very little worn):

	DP_2—DP_4	M_1		M_2			M_3		
	L	L_k	H	L_k	H	Index	L_k	H	Index
G. gaudryi type: Loc. 114 S	23.7	11.0	10.0	13.4	14.1+	95.0	15.5	15.8	98.1
Loc. 29	—	9.1	8.0	10.5	11.4+	92.1	13.2	12.0	110.0
Loc. 73 (1935, Pl. XI: 6 & 7)	23	10.8	9.1	13.8	13.8	100.0	—	—	—
Loc. 73 (1935, Pl. XI: 9 & 10)	23	10	10.1	11.8	13.0	90.8	—	—	—
Loc. 73 (1935, Pl. X: 10) .	—	—	—	12.2	12.3	99.2	—	—	—
Loc. 78	(22.5)	10.2	7.7	11.5	11.0+	104.5	14.8	12.5	118.4
G. dorcadoides (Loc. 30_5) .	23.5	11.2	12.2	13.0	18.0+	72.2	M_3 not calcified		

Loc. 114 N: One fragment of a skull comprising the palate with the teeth of both sides and parts of the skull base (P^2—M^3 55.1, for other measurements see the table on p. 120). The front part of another skull (figs. 21 & 22), with the complete premaxillae and part of the right horn-core, the nasals are evidently also complete (P^2—M^3 about 55 mm; M^2—M^3 about 24 mm; base of horn-core 28 × 21; orbita L 36, H 27; length of nasals 49). Several lower jaws.

There are quite a few characters, which indicate that the skull fragments are of the larger type represented at Loc. 114 S by one single skull. The basis cranii has a similar structure, the bullae are large. The nasals are attached to shallow notches in the frontals, the naso-frontal suture has, however, the form of a very broad ∩. The free end of the bones is pointed. They are considerably shorter than the nasals of the smaller skulls from Loc. 114 S, which seems to be entirely due to the difference in the naso-frontal contact. The ethmoidal fissures evidently had the same extension backwards as in the larger skull from Loc. 114 S (they can be traced at least to the level of the posterior ends of the nasals, further back their borders are damaged). The orbits are compressed from above and a part of their posterior rim is missing (fig. 21), but it is evident that they must have been much larger than in the smaller skulls from Loc. 114 S. The skull fragment mentioned in 1935 (p. 89) is also of the same type, although the teeth are smaller (P^2—M^3 53.5; M^2—M^3 21.5; horn-base > 26×22). The almost complete horn-core in fig. 23 is also a new acquisition from Loc. 114 N. Its length along the anterior curve is 120 mm (125 with the tip complete?) and the cross-section at the base 29×20 mm (the base is slightly crushed from the sides). This cross-section has exactly the same dimensions as the one in fig. 73 d (1935), there is however a broad flat-bottomed groove on the posterior side. The curvature of the horn-core is intermediate between that of two horn-cores from Loc. 48 (1935, text-fig. 62 and 63) the horn from Loc. 114 N tapers, however, more rapidly towards the tip, and the cross-section is more elongated. There is very little doubt that the horn-core belongs together with the skull fragments found at the same locality, although not to the same individual as anyone of these.

In my paper of 1935 (p. 90) I have mentioned that a P_4 in a jaw from Loc. 114 N is more complicated than any other P_4 among the material available at that time. I now have 7 specimens of the P_4 from the locality, one of these even a little more advanced than the one figured in 1935 (Pl. XII: 6 & 7 = fig. 7 in the present paper). On the whole the P_4 from locality 114 N are more complicated than those from other localities, but there is a fairly complete series of stages from such identical with even moderately complicated P_4 from for instance Loc. 49 to the most advanced ones, which are unique (see figs. 6—7, the least complicated P_4 from Loc.

114 N (Pl. II, fig. 8; only internal view) comes between the specimens b and c from Loc. 49, see figs. 3 & 4). An accessory element, contributing to the complication as on the P_4 from Loc. 49, is only faintly indicated on one of the P_4 from Loc. 114 N. The inner wall seems to be produced by the fusion of the metaconid and the paraconid only. In this regard the material agrees with that from Loc. 44, 108, 114 S and others (compare 1935 Pl. XII: 7 & 9 and XI: 17 & 18). This difference probably has no systematical significance, but it shows somewhat different ways in which a complete inner wall on P_4 might have been obtained.

The height of the lower molars is seen in the following table, in which measurements for two jaws of the *G. dorcadoides* type have been inserted for comparison (»Loc. 109» = 1935, Pl. XII: 21):

Locality	M_1		M_2		M_3	
	L_k	H	L_k	H	L_k	H
114 N 1	9.8	7.1+	11.9	12.3+	16.8	15.1
2	—	—	12.0	13.6+	16.3	16.4
3	—	—	—	—	15.5	13.2
4	—	—	12.7	?12.5+	15.8	15.2
5	—	—	12.7	12.7+	16.5	14.1
6	11.7	12.6	—	—	—	—
43 (*G. gaudryi*)	11.0	8.9++	13.7	12.7+	15.0	15.0+
109 *G. dorcadoides* . .	12.3	14.3+	14.9	19.9	—	—
43 (Pl. II, fig. 4) . . .	12.0	10.0++	14.8	14.9++	18.8	17.5+

In the jaws from Loc. 114 N the M_2 is worn but by far not as much as the M_2 from Loc. 43 (Pl. II: 4), which I without hesitation have referred to the *Gazella dorcadoides* type. This M_2 must before it was worn have been about as high as the one from Loc. 109 (Index 73.9). About the M_3 compare p. 89.

The material described above would according to my classification in 1935 have been referred to *Gazella sp.* (aff. *gaudryi*) and to *Gazella sp.* (? *paotehensis*). My material was at that time comparatively small and it seems as if my *G. sp,* (? *paotehensis*) comprises at least two types — they may be called races, subspecies or species, or they may be included as subordinate forms under *Gazella gaudryi.* In my material they are however well separated and they are evidently also distinct from *G. gaudryi.* As far as I can see, no evidence has been brought forth by TEILHARD, TRASSAERT and YOUNG (1931 and 1938), which could give us right to interpret the whole material as belonging to one single species, as most of the characters considered by me have not even been mentioned.

It is, however, necessary to confine the denomination *Gazella sp.* to a more limited material, and this is easy, as I had one single specimen in mind, when I tried to identify it with *Gazella paotehensis:* »Ich habe *Gazella paotehensis* TEILHARD & YOUNG mit einem Fragezeichen als Synonym angeführt, weil die Oberkieferzähne (l. c. Pl. VII, fig. 3) genau mit denen eines Gaumenstückes von Lok. 114 übereinstimmen, und weil der grösste Teil meines Materials auch von Paotehsien, Shansi, stammt.» (1935, p. 90). This palate is now figured (Pl. II, fig. 6). It is of exactly the same size as a palate associated with a part of a horn-core (the skull fragment figs. 21 & 22; P^2—M^3 in both cases L_b 59.0), and it is thus evident that *Gazella sp.* BOHLIN 1935 refers to the larger form (as I have tried to show above the skull fragment in question is very similar to the larger form from Loc. 114 S). As far as I can see the horn-core in fig. 23 is very similar to the one figured by TEILHARD & YOUNG (1931 Pl. VIII: 2), only the cross section at the base may be a little broader in *Gazella paotehensis*, but, as mentioned above, the horn-core figured by me is slightly crushed at the base, and, furthermore, there is a horn-core from the same locality (1935, text fig. 73 c), with a comparatively broad cross section at the base. By a strange coincidence there occurs in the material from the same locality as these remains, which very closely resemble the type material of *Gazella paotehensis*, lower jaws with a far going complication of the P_4, just as in *Gazella paotehensis* as announced by TEILHARD & YOUNG. In the jaws from Loc. 114 N, in which the P_4 shows the highest development, the length of P_2—M_3 is equal to the length of $^1/_2 P_3$—M_3 in the jaw figured by TEILHARD & YOUNG (1931, text fig. 5, Pl. VII: 4); P_2 and P_3 are more reduced in comparison with the P_4 and the molars, and both the teeth and the jaw are much slenderer, and therefore, in my opinion, the jaws from Loc. 114 N hardly can belong to the same species as the one figured by TEILHARD & YOUNG. But the teeth of the jaws from Loc. 114 N fit exactly on the teeth of the palate (Pl. II: 6) and there is very little doubt that the jaws and this palate belong to the same species.

I do not think that my classification in 1935 can have done much harm. The species name *gaudryi* was in the first place used for the material from Loc. 73, which seems to be very uniform. The rest of the material referred to the same species is scanty, the tooth material is however very close to that from Loc. 73. The greatest deviation is shown by the jaw from Loc. 70 (1935, Pl. XI: 1 & 2), its teeth being both in size and structure closer to the material from for instance Loc. 114, i. e. of the slightly higher type, which I in 1935 was inclined to refer to a separate species, a fact which also was pointed out (l. c. p. 90). *Gazella sp.* was based on, may be small, differences which I still think cannot be entirely neglected.

The teeth of *Gazella sp.* are as I pointed out in 1935 similar to those of *Gazella gaudryi.* In spite of the relative height of the teeth, the whole

row of teeth, especially the upper one, has the same brachyodont appearance as in *Gazella gaudryi*. At the reexamination of the material it seems to me, however, that the teeth referred by me to *Gazella sp.*, and above all the lower molars, show a slight advance in the direction of *Gazella dorcadoides*, i. e. the ribs and other structural elements on the inner side of the lower molars are more delicate than in the true *G. gaudryi*. This does not mean, however, that this *Gazella sp.* blots out the limits between the *Gazella gaudryi* type and the *Gazella dorcadoides* type of dentitions. The upper teeth are so similar to those of *Gazella gaudryi* that it is hard, or even impossible, to tell them apart, whereas there can never be any hesitation, which upper dentition is referable to either of *Gazella gaudryi* or *Gazella dorcadoides* (and related forms), provided the teeth are in tolerably good condition. Even isolated molars can in most cases easily be referred to either type.

The dentition may prove to form an unsafe basis for further subdivision of the gazelles of the *gaudryi* type, but the differences in skull structure can possibly be used as species characters. At present three forms have to be taken into consideration:

1) the smaller form from Loc. 114 S (*Gazella* Loc. 114 S »small»), distinguished by the shape of the nasals, the small orbits, the small bullae and the small orbits from

2) the larger form from the same locality, which seems to be close to the gazelles of the *gaudryi* type from Loc. 43, 44 and 114 N (= *Gazella sp.* BOHLIN 1935). The female skull probably belongs to the same form, although its bullae are comparatively small. This large form may be identical with

3) the true *Gazella gaudryi* from Loc. 73, but there is still at least the slight difference in the dentition to be accounted for and it is possible that a large material of jaws, with well preserved teeth and different stages of wear represented by several specimens, may give a sufficient basis for a separation. The male skull from Loc. 114 S and the female skull from Loc. 44 are similar, and they differ from the male from Loc. 73 and the female skull from Wu-hsiang-hsien by their somewhat higher skull, somewhat larger braincase and also larger orbitae, the male skull by its horncores.

These cranial characters, especially the ones last mentioned, may be of no importance (which however remains to be proved), but I think it is better to try to distinguish between a number of fixed types, until enough material has been found to allow a right appreciation of their systematical value, than to work with elastic groups in which almost anything seems to fit.

The skull fragment from Loc. 49 described in 1935 as *Gazella sp.* (aff. *gaudryi*) cannot at present be included in any of the three divisions summarized above.

It is of course impossible to compare these »forms» with the forms described by TEILHARD & TRASSAERT as different characters are used for the classification. The dentitions figured as *G. gaudryi* (SCHLOSSER) and *G. gaudryi* form A are however, as I already have pointed out, undoubtedly of the *Gazella gaudryi* type (evidently even the true *Gazella gaudryi* SCHLOSSER 1903).

Dentition of the Gazella dorcadoides type.

Under the heading of »*Gazella dorcadoides*-ähnlichen Antilopen» I described in 1935 three forms: one larger *G. altidens*, one middle-sized *G. dorcadoides* and one small *G. dorcadoides*? subspecies. The material was rather small, and the forms were distinguished from each other only by the size (l. c. p. 94). The new material does not carry us any further as to the difference between *G. altidens* and *G. dorcadoides*, and I regret that I used the name *altidens* in this connection, as I ought to have realized already in 1935 that the lower teeth are inferior to the upper ones as a basis for the classification. The name *altidens* should have remained with the upper teeth described and figured by SCHLOSSER (1903, Pl. XI: 4), which are clearly distinct from those of the *Gazella dorcadoides* type. The upper teeth were referred to ? *Tragoreas lagrelii* BOHLIN 1935.

I now have in all 23 upper dentitions with at least three molars in fairly good condition. No new localities were added to the list (1935, p. 90), but a rather good skull und several skull fragments were added to the material from each of the localities 30 and 109. Measurements: Length M^1—M^3, other measurements in brackets (y = young, o = old):

Loc. 30: 30.2 (o) (P^2–M^3 52.2, P^3–M^3 45.3); ?31 (y) (P^2–M^3 ?50.5, P^3–M^3 ?44); 31.2 (P^3–M^3 44.4).
31.3 (o) (» 50 » 43.4); 32 (y) (» 52.2, P^3–M^3 45.3); 33.2.
?33.3 (y) ?33.5 (y) 33.6.
34.2 (y) 35.3 (P^3–M^3 50.1); 35.3.
35.4 (y) 35.6.

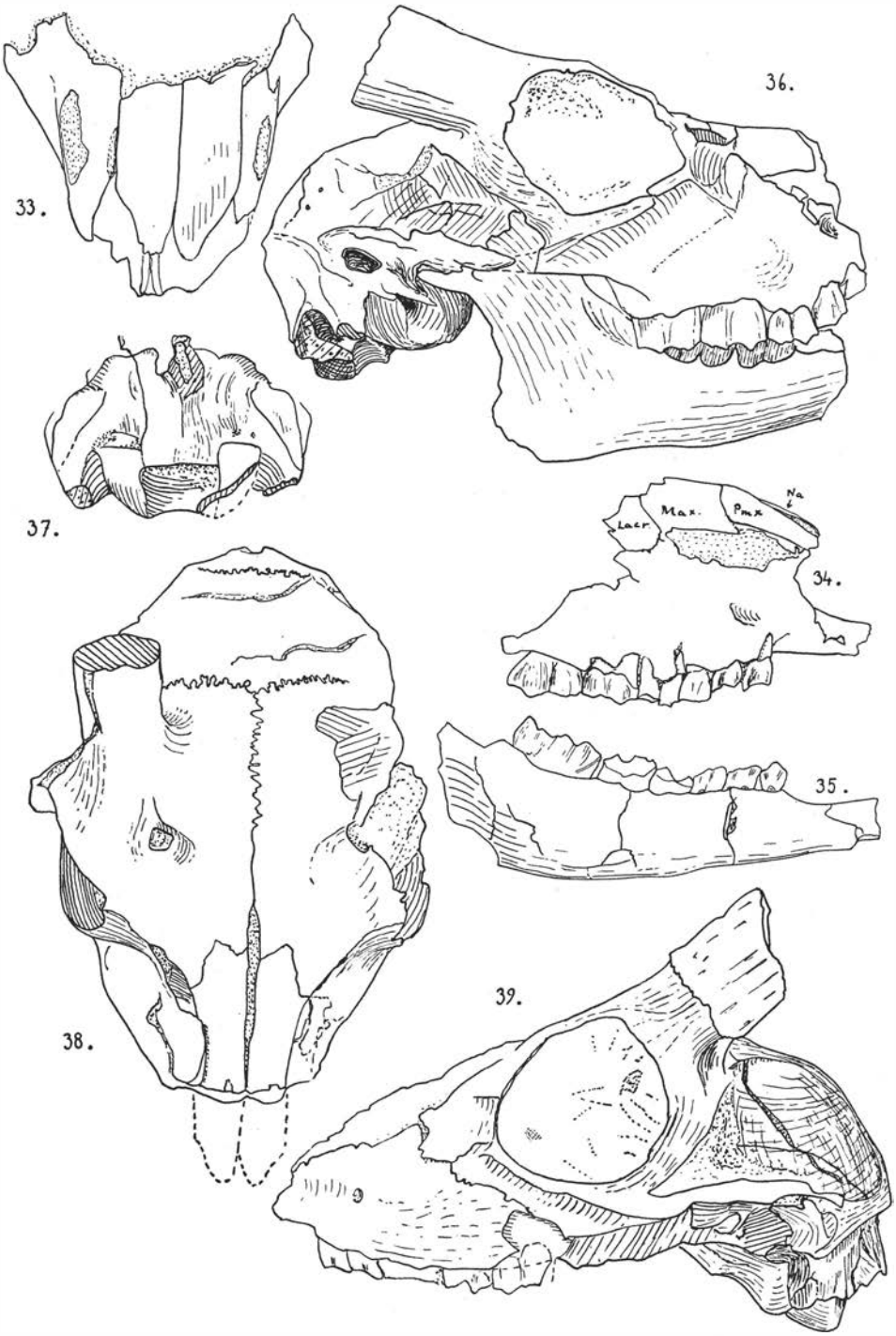
Loc. 31: 31.0 (» 49.7 » 43.5).

Loc. 49: 35.0 (y) (» 56.4 » 48.5).

Loc. 109: 33.0 (» 54.4 » 47.4); ?33.5 (o) (» ?56 » ?48.7); 33.9 (P^3–M^3 47.1).
34.2 (o) (» 53.4 » 46.8); ?35 (o) 35.1.
36.1 (y) 38.4 (y) (= L_k $M^1 + M^2 + M^3$;
Pl. I, fig. 9; ?Loc. 109).

Loc. 114 S: 26.4 (P^3—M^3 = L_k $P^3 + P^4 + M^1 - M^3$ 38.7, compressed antero-posteriorly, Pl. I: 13).

It is evident from these measurements that the material from Loc. 109 is on an average larger than that from the other localities, and it should be noticed that many of the shorter molar series from Loc. 109 are from old individuals, whereas many of the longer ones from the other localities are only little worn. One difficulty is that the length of M^1—M^3 changes


33.
36.
37.
Lacr
Max.
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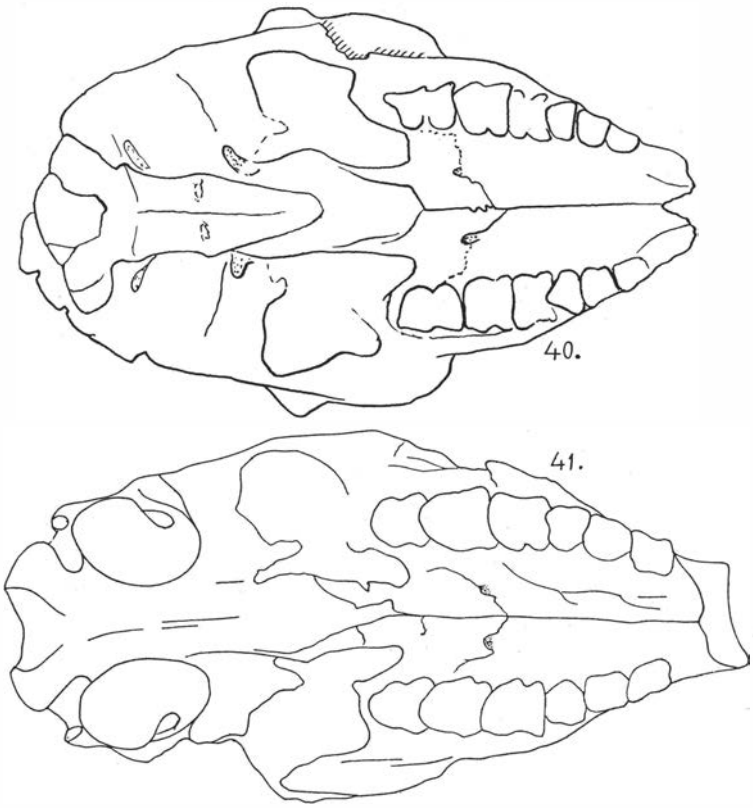
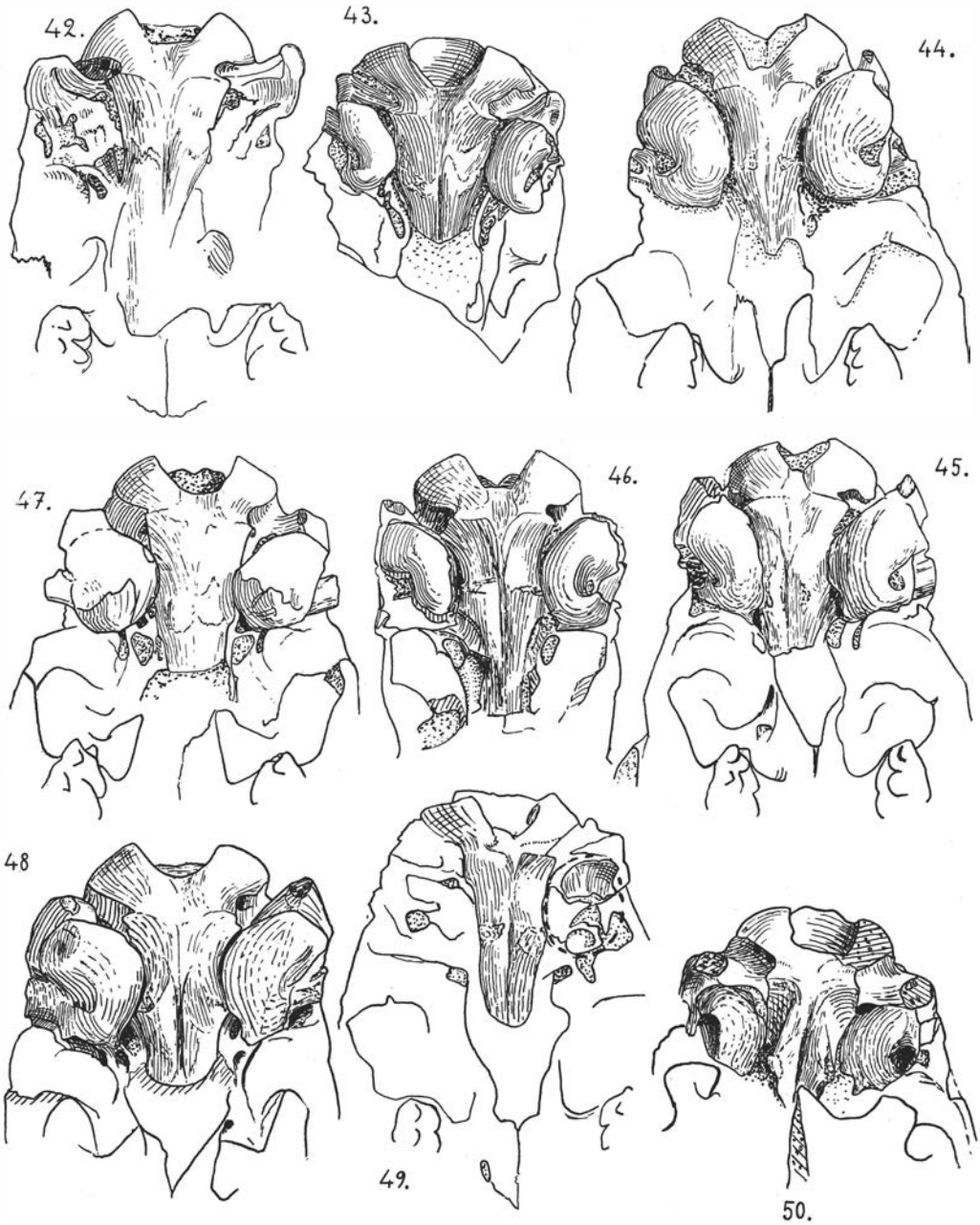
considerably as the teeth are worn (see for instance the M^2 in Pl. I, fig. 9: the length at the present wear surface is 14.5, at the point where the enamel ceases at the anterior and posterior sides of the tooth only 12 mm, if further worn the tooth would shorten also because the dentine on these two sides is unprotected). What led me to treat the material as two



Figs. 40 & 41. Ventral views of the skulls in fig. 39 (= fig. 40) and 32 (= fig. 41).

separate species, was a comparison between two palates (Loc. 31 and 109, the only in some degree complete material available in 1935), of which the one from Loc. 109 has much larger teeth (M^2—M^3 = ½ M^1—M^3 in the specimen from Loc. 31) than the other. Regarding the material from Loc. 114 S I refuse to believe that it can be the question of only a local variety of the larger form. The length of P^3—M^3 (with correction for the deformation in the premolar region) is almost one centimetre shorter than

Figs. 33—35. Skull fragment of the *Gazella dorcadoides* type with the lower jaw. Fig. 33. Top view. Fig. 34. Lateral view. Fig. 35. Inner view (right lower jaw reversed). Loc. 109.
Figs. 36—38. Skull and lower jaw of the *Gazella dorcadoides* type. Lateral, occipital and top views. Loc. 109.
Fig. 39. Skull of *Gazella dorcadoides*. Lateral view. Loc. 30.
Figs. 33—39 two-third natural size.



Figs. 42—50. Basicranial views of the following skulls (two-third natural size):

Fig. 42. Same as figs. 25—27. Loc. 114 S, »small».
Fig. 43. Same as figs. 30 & 31. Loc. 114 S ♀, »small».
Fig. 44. Same as figs. 32 & 41. *Gazella gaudryi* ♀, Wuhsianghsien.
Fig. 45. Same as figs. 54 & 55 (BOHLIN 1935). *G. gaudryi*, Loc. 73.
Fig. 46. Same as figs. 58 & 59 (BOHLIN 1935). *G. ?gaudryi*, Loc. 70.
Fig. 47. Same as Pl. XI: 19 (BOHLIN 1935). *Gazella sp.* ♀, Loc. 44.
Fig. 48. Same as figs. 20 & 24. *Gazella sp.*, Loc. 114 S, »large».
Fig. 49. Same as fig. 39. *Gazella dorcadoides*, Loc. 30.
Fig. 50. Same as figs. 36—38. *G. dorcadoides* type, Loc. 109.

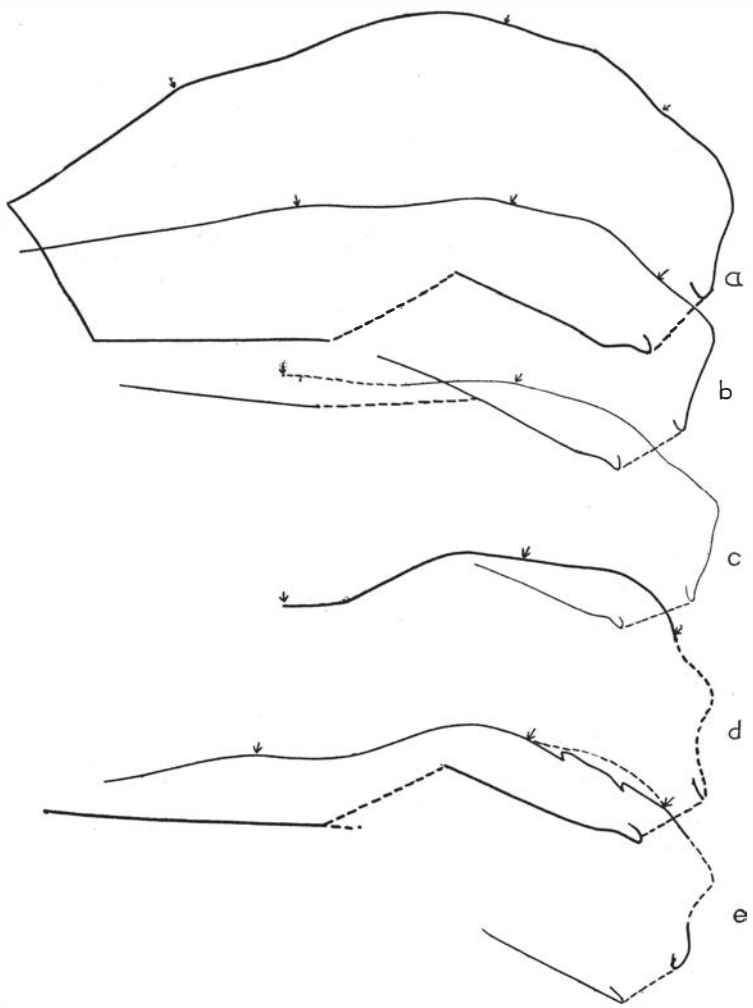


Fig. 51. Longitudinal sections through the following skulls (diagrams based on measurements, two-third natural size): a) *Gazella sp.* Loc. 114 S, »large» (= fig. 20). b) *Gazella.* Loc. 114 S, »small» (= fig. 26). c) *Gazella.* Loc. 114 S ♀ »small» (= fig. 31). d) *Gazella dorcadoides.* Loc. 30 (= fig. 39). e) *Gazella dorcadoides* type (*altidens*). Loc. 109 (= fig. 36).

the average of the material from Loc. 109 (see Pl. I, figs. 12 & 13; M^2—M^3 in the larger jaw is of the same length as M^1—M^3 in the smaller one; compared with the palate from Loc. 31 the relation is M^2—$M^3 = {}^1/_2\ M^1$—M^3).

I maintain the three »species» distinguished in 1935, but with much less certainty regarding the *G. altidens* as separate from *G. dorcadoides*.

The skull.

In 1935 I described a skull from Loc. 43 as *G. dorcadoides*. As seen in the figures (l. c. p. 93) this skull is rather defective and the few teeth

still preserved are very much worn and in a very bad condition. The main characters considered were: the narrow basis cranii, small bullae osseae, short lachrymals and small orbits. The teeth were in this case useless, but the material now available seems to verify my determination. I now have, in all, three more or less complete skulls and several skull fragments, and it seems possible to state certain constant differences from the skulls with a dentition of the *Gazella gaudryi* type.

The condyli (in 3 specimens) are comparatively small and one, therefore, has the impression that the whole posterior part of the brain case is narrow (compare fig. 49 & fig. 50 with the figures of other skulls on the same page). The basis cranii (basioccipital + basisphenoid; 3 specimens and partially in a fourth) is very slender. In the skull from Loc. 30 it is almost cylindrical, the posterior tuberosities form prominent transverse ridges, the tubercula pharyngea are less prominent rounded knobs. In a skull fragment from Loc. 43 the basioccipital is flattened and much like the type from Loc. 114 S in fig. 43. In the skull from Loc. 109 the posterior tuberosities are more pointed and from them strong ridges run forwards and outwards to the strongly developed, wing like tubercula pharyngea (compare p. 100). The middle of the basis cranii is in this specimen deeply grooved. The original skull from Loc. 43 was evidently intermediate between the two extremes found in the other skulls. The bullae are small, but well inflated and almost spherical (3 specimens, in the fourth they must have been of the same size as in the others, see fig. 49).

The occiput is small and semicircular (fig. 37), the mastoids occupy about the same area as in the smaller skulls from Loc. 114 S. In the skull from Loc. 30 the occiput is abnormal: the left condyle is divided by a deep groove — a partial duplication of the foramen magnum — and at its posterior end this groove is overshadowed by a prominent bone fringe in the middle of the left half of the occiput — a duplication of the occipital crest? (seen in fig. 40). The true occipital crest is normal, although comparatively strong.

The sutures on the upper surface of the skull are only slightly thickened. The orbits are in the new skulls somewhat larger than in the skull figured in 1935, but they are decidedly smaller than in the larger skull from Loc. 114 S (it seems as if this skull, the female skull from Loc. 44, and probably also the skull fragments from Loc. 114 N were the exceptions, and the rest of the material including *Gazella gaudryi* from Loc. 73, all with small orbits, represent the most common type). The nasals are preserved at least to some extent in 10 specimens. In 9 of these and in 3 others in which the nasals themselves are lost, the naso-frontal suture is seen. This is in most cases **M**-like, sometimes the projecting angle at the posterior end is straightened out, and in one case (Loc. 109) the suture is very

nearly Λ-shaped. The sides of the nasals are folded down and run parallel, except for a slight widening, where they join the frontals. The ethmoidal fissures (12 specimens; see fig. 38) are short and broad, their posterior end lies in front of or level with the most posterior point on the naso-frontal suture. The shape and extension of the lachrymals are seen in 11 specimens. These bones are comparatively short, and their most anterior point lies above M^1 (usually it does not extend beyond the middle of this tooth). The lobe of the jugals in front of the orbit is also short. This condition seem to indicate that the face region of the skull is short, a fact which also expresses itself in the sudden narrowing of the face in front of the orbits (compare fig. 38 and fig. 75 (1935) with figs. 18 & 27. It seems to me that the skull figured by TEILHARD & TRASSAERT (1938, fig. 6 = *Gazella gaudryi*, form B), is of the same type; notice the small bullae reconstructed in the side view).

The horn-cores were small or at least slender (measurements for the cross section at the base in the table p. 120) and they stand wide apart on the skull. In 1935 I figured a horn-core from the same locality (text figg. 66, 71 and 72 *o*), which may belong to the same species (the cross-section at the base is more nearly circular (21 × 20 mm) but the angle formed with the upper surface of the skull, the form of the horn-pedicle and the appearance of the scanty remains of the skull associated with the horn-core are very similar).

Seen from below the skull decidedly makes the impression of being shorter and broader than the skulls of the *Gazella gaudryi* type (compare fig. 40 and fig. 41); also the muzzle in front of the P^2 was probably shorter.

Some of the characters found in the skulls described above were also found in the smaller gazelle from Loc. 114 S. The basis cranii is very similar, also in the form of the tubercula pharyngea in specimens where they are extremely developed. The bullae are in both cases small, but in the skulls from Loc. 114 S they are compressed laterally and evidently much less inflated. The horn-cores are in both cases small, but if the horn-core figured in 1935 is rightly referred, their form is rather different (slender and straight in the form from Loc. 30, distinctly curved in the other one; compare, however, TEILHARD & TRASSAERT 1938, Fig. 6). The similarities do not imply, however, that the smaller form from Loc. 114 S is an intermediate form in the sense that it opens the way for a fusion of all the gazelles described above into one single very variable species. It is as far as my material goes distinct from both *Gazella gaudryi* (and the larger form from Loc. 114 S) and from *G. dorcadoides* (and related forms), but its dentition and also other characters, as for instance the long lachrymals, bring it closer to the former.

Gazella »*gaudryi*» Schlosser 1904 (Samos).

Gazella gaudryi Pilgrim & Hopwood 1928.
Gazella pilgrimi Bohlin 1935.

Teilhard & Trassaert say about this form (1938, p. 7): »We regard it» (i. e. *G. gaudryi* from the pontian of China) »as practically undistinguishable from the Samos *Gazella* described under this very name by Pilgrim & Hopwood (1928), but renamed as *G. pilgrimi* by Bohlin (1935 p. 103)».

The name is of course Schlosser's, and there was never any question about an identity with the Chinese form; »*Protetraceros*» *gaudryi* is not even mentioned in connection with *Gazella gaudryi* (Schlosser 1904, pp. 66—68). The form is discussed in the same paper but as a representative of the subfamily *Cephalophinae* (l. c. p. 92), and Schlosser has maintained this classification at least as late as in 1923 (Zittel's »Grundzüge» 4th German edition, p. 592). Neither have Pilgrim & Hopwood one word about »*Protetraceros*» *gaudryi;* their discussion regards exclusively the Samos form. As far as I know, the true nature of »*Protetraceros*» *gaudryi* was first recognized by Teilhard & Young in 1931, although the material described by these authors seems to be of the *Gazella dorcadoides* type.

Gazella gaudryi Schlosser 1904 and *G.* (»*Protetraceros*») *gaudryi* (Schlosser) 1903 are thus two different things at least as they appear in the literature, and, when the latter is included in the Genus *Gazella*, the former has to be renamed. They may be identical, but this has to be proved and, as far as I can see, the evidence is against an identity.

Schlosser (1904, p. 66) compares *Gazella deperdita* with his new species from Samos and states among other things: »Ausserdem sind ihre Prämolaren auch im Verhältnis grösser und ebenso wie die Molaren auch etwas dicker als bei der *Gazella* von Samos. Ferner sind die Molaren noch nicht so hoch geworden, sie besitzen auch sämtlich Basalpfeiler . . ., während bei der neuen Spezies die Molaren sehr beträchtliche Höhe, aber mit Ausnahme des M1[1] keine Basalpfeiler haben . . . Die Rippen und Falten an der Aussenwand der oberen Prämolaren und Molaren sind viel undeutlicher als bei *deperdita*.»

In 1934 I had the occasion to see Schlosser's types, and I summarized my impression in my notes thus: »*G. gaudryi* is a 'flat walled' type» (= inner wall on the lower and outer wall on the upper molars) »with semihypselodont teeth, somewhat larger than *brevicornis*» (compare Bohlin 1935, pp. 101—102). Further I have seen material of *Gazella* from Samos in Berlin, Vienna, Lausanne, Stuttgart, Frankfurt a. M. and Münster i. W., and been able to state that the characters observed in Schlosser's types

[1] Schlosser probably means the *lower* M 1 although this is not quite clear from his description.

dominate the material of teeth from this locality. I must confess that I had not paid any attention to SCHLOSSER's description of the teeth, neither when I studied his types, nor when I wrote my paper (1935), so that my idea of the structure of the teeth was independently formed.

In their paper 1929 ARAMBOURG & PIVETEAU describe *Gazella gaudryi* (*pilgrimi*) from Saloniki and mention among other dental characters (p. 46): »La muraille externe des arrière-molaires est légèrement plissée, mais beaucoup moins que chez *G. deperdita* . . .» These authors state that *Gazella gaudryi* (*pilgrimi*) does not seem to differ, neither in its cranial, nor in its dental characters from *G. schlosseri* PAVLOW and this latter name is put as a synonym — a thing which I overlooked in 1935. It seems to me, as if the horn-pedicles in PAVLOW's species were higher than in *G. pilgrimi* (PAVLOW 1913, Pl. II), but if the two species really are identical, it is evident that the species name *schlosseri* has the priority to my new name *pilgrimi*. A species *G. schlosseri* ANDREE 1926 (= *Gazella* sp. SCHLOSSER 1904) was renamed as *G. mytilini* by PILGRIM & HOPWOOD, as the species name *schlosseri* was preoccupied.

Finally, PILGRIM in his paper (1937, p. 810) states about the dentition of a skull from Samos (Amer. Mus. No. 20570): »The dentition is not unlike that of *G. lydekkeri* in regard to the length of the individual molars and premolars and their degree of hypsodonty. The folds and ribs on the external walls of the upper molars are little weaker than in the Indian species, but those of the upper premolars are less prominent and the internal surface of the lower molars it almost flat.»

Thus different authors have observed and emphasized the flatness of the outer wall of the upper and the inner wall of the lower teeth of *G. pilgrimi*. As mentioned, both SCHLOSSER and ARAMBOURG & PIVETEAU have come to this result after a comparison with the teeth of *G. deperdita*, and the teeth of this species are very, very similar to those of *G.* (»*Protetraceros*») *gaudryi*, especially the form from Loc. 73, a fact noticed by SCHLOSSER in 1903 (p. 138: »sehr nahe»), although he denies that the subfamily *Cephalophinae* can be derived from *G. brevicornis* (*deperdita*) »da ihr Zahnbau entschieden primitiver ist als bei dieser fossilen Gazelle».

In conclusion I would say that, if some series of teeth of *Gazella brevicornis* were mixed with the material from Loc. 73, it would be impossible to tell the Pikermi form and the Chinese form apart, whereas this certainly would be possible with *G. pilgrimi*.

Concluding remarks.

In the introductory remarks to their chapter on the genus *Gazella* (p. 2) TEILHARD & TRASSAERT ask: »Who among the palaeontologists would dare to proclaim his faith in the value and in the practical use of the

various species of *Gazella* reported in the scientific literature for Pontian only (Pikermi, Samos and Maragha)?» The answer is evident, but this does not mean that all species are equally doubtful, and the practical use does not increase, if a lot of doubtful species are made into one; neither does it decrease, if the more doubtful ones (usually based on insufficient material) are kept apart awaiting further discoveries. We are at present only concerned with the Pontian gazelles from China, and I do not hesitate to say that there are with certainty two types of small gazelles among the Pontian material from this country, namely the ones originally described by SCHLOSSER, but both these types seem to be rather complex. What Professor TEILHARD and his associates are trying to find is evidently a Pontian form, which links the bulk of the Pontian gazelles up with the later Chinese forms of the genus. *G. paotehensis* is supposed to be such a form, but also inside their *Gazella gaudryi* group these authors believe to have found a form (*Gazella gaudryi*, form B) which approaches the *Gazella blacki* type in different ways (1938, p. 8). I have already given my opinion about this form B (p. 85).

The new complete description of *Gazella blacki* (TEILHARD & TRASSAERT 1938) seems to remove all obstacles, which prevented me from referring *Gazella kueitensis* BOHLIN 1938 (p. 12) to that species, and thus I have material available for a comparison between *Gazella blacki* and the Pontian gazelles. It is quite possible that *G. blacki* has its origin from *G. gaudryi* and allied forms. As far as the dentition is concerned, an increase in size and hypselodonty would produce the type of teeth found in *G. blacki*. The origin of this form lies perhaps rather among the most brachyodont forms with teeth of the *Gazella gaudryi* type, those for instance from Loc. 73 and others from SE Shansi figured by TEILHARD & TRASSAERT (l. c. figs. 3—5), in which the ribs on the molars are very pronounced. The *Gazella dorcadoides* type is, in my opinion, excluded from the ancestry of *G. blacki*. Its molars are decidedly hypselodont, but it has gained this at the cost of the ribs on the posterior lobe of the upper molars and more or less of all relief on the inner surface of the lower molars, and it seems to me very unlikely that in a line of evolution these elements would temporarily disappear — in *G. blacki* they are well developed.

It is possible and even probable that all the Pontian species from China have a common origin, from which *G. gaudryi* (Loc. 73) is less removed than the rest. It is interesting to observe that the Pontian forms seem to be the products of two lines of evolution:

1) one line leading to *Gazella dorcadoides* has acquired hypselodont molars, but has retained the simple premolars (of P_4 I have more than a score of specimens in my material, none of these is complicated, and only about half of them shows a groove, which marks off the metaconid from

the protoconid anteriorly, the slit between the metaconid and the paraconid is however on all specimens very wide).

2) Another line leads, evidently via a form like that from Loc. 73, to forms with somewhat higher teeth (at least the relief on the inner side of the lower molars becomes more delicate), and premolars with a decided tendency toward complication, the most complicated P_4 having a complete inner wall as well developed as on any of the specimens of *G. blacki* figured by TEILHARD, TRASSAERT and YOUNG, but from a simple P_4 to these most complicated ones there is, as already stated above, a complete series of transitional types.

In their paper of 1938 TEILHARD & TRASSAERT also describe more material of *Gazella sinensis* TEILHARD & PIVETEAU and of another gazelle found together with this. When I wrote my paper published in 1938, I was not sure about the characters of the forms described from Nihowan. The new description removes the difficulties to some extent. As far as I can see, my species *G. paragutturosa* cannot be identical with *G. sinensis*, its horn-cores are, for instance, slenderer and much less recurved. They resemble more those of *G.* cfr *subgutturosa*? TEILHARD & TRASSAERT 1938 (fig. 27) and they are even more like those described as *Gazella sp.*, type d (l. c. fig. 31). But in the lower jaws, found together with the skull material of *G. paragutturosa*, the P_4 is complicated, and the species can for several other reasons not be identical with the living *G. subgutturosa*.

Gazella sinensis is evidently present among the material in Uppsala, and I am now inclined to refer the skull fragment from Loc. 103 (BOHLIN 1938, Pl. VI: 1 & 3) to this species (compare TEILHARD & TRASSAERT 1938 text fig. 23).

Of the rest of the *Gazella* remains recently figured by TEILHARD & TRASSAERT the horn-core in fig. 29 interests me, because of its close resemblance to two of the horn-cores described by me in 1938:

1) BOHLIN 1938, Pl. VIII: 5 & 6, text fig. 8 b. This horn-core comes from the loess, the size seems, however, to be exactly the same.

2) l. c. Pl. VII: 9, text fig. 7 c. This horn-core ought to be of about the same age as the one figured by TEILHARD & TRASSAERT. The front view (not figured by me) is very similar. My specimen is a couple of centimetres longer.

It would be interesting to get more material of this form, as it seems to me to be clearly distinct from the species based on more complete material.

It seems perhaps from the various papers published on the Pontian Gazelles from China, as if the views hold by Professor TEILHARD and his associates and those maintained by me (adopted from SCHLOSSER) were

entirely incompatible. The main divergency lies at present in the different opinion about the status of *Gazella dorcadoides* SCHLOSSER, and I hope that I have been able to show in the present paper that the difference between the two types originally distinguished by SCHLOSSER is so great that it cannot be explained by assuming a great variability in one single species.

The material at my disposal is by no means small, and as far as the dentition is concerned it is in most regards more than sufficient to make sure that the differences observed are not merely accidental. I have had my days of doubt, not on the distinctness of the two types, but on the possibility to present the evidence in a convincing form, but I have always regained confidence by looking at the upper half of Pl. I. The M_3 seems to be a stumbling block, but one only has to go to the tooth in front of it to encounter again the great difference in height found in the upper molars (see p. 90). It is only to be regretted that completely or nearly unworn M_3 are much more common, than specimens of M_2 in a very early stage of wear.

There *are* two different types of dentitions, but I must add, *at least* two. A look at the lower jaws and jaw fragments figured in 1935 and in the present paper makes one wonder, if there is not more behind the rather great differences found in what has been here comprehended as the *Gazella gaudryi* type than merely a number of local varieties; compare for instance Pl. I, fig. 5 and Pl. II, fig. 9 (in the former the wear is somewhat more advanced).

It has to be noticed that if only the P_4 is taken into consideration, and, to that, only one detail in the structure of P_4, the dentition certainly cannot be of much help for the classification of the Pontian gazelles. I have, however, devoted a part of the text and several figures to this tooth in order to demonstrate, what value I would attribute to it (see especially p. 116).

It is not necessary to destroy complete and beautiful material to study the different dental characters discussed above, in most cases they are plain enough without special preparation. But in a collection of fossils there is always a certain amount of otherwise useless fragments of jaws, which can supply a sufficient material for a comparative study of dental characters, which are usually difficult to get at.

In the present paper I have avoided new species names, although I have felt tempted to introduce at least one, and I have as much as possible avoided terms as »form» and »group», in order not to collide with the systematic units distinguished by TEILHARD, TRASSAERT and YOUNG, but from my point of view insufficiently characterized. The elusive *Gazella paotehensis* has more than anything else caused my passivity, partly because I have »guessed» once and still do not know, if I have guessed right or

not. I have repeated my question from 1935, more plainly this time (see p. 105).

The Chinese Pontian gazelles have been approached from two different directions, and this is, of course, only of advantage for the wider knowledge of the genus. When the work has proceded so far that the results can be compared, the question arises, which group of characters will supply a basis for a division into larger groups and which will have to be regarded as subordinate.

Let us assume that two scientists, as also seems to be the real case, have both had access to a similar material of about the same size, including a number of skulls: A, B, C, D . . . A marked difference in the structure of the horn-cores and certain other characters make a subdivision into two species possible 1) A, B; 2) C, D. But it can be shown that of these four skulls A, C have one kind of dentition and B, D another, the two kinds as different as the ones figured in Pl. I. It will, therefore, be necessary to recognize four different forms, and the task is to arrange these in two groups, as natural as possible. Which characters are most likely to furnish a safe basis for the classification, those taken from the dentition, or those taken from the horn-cores? In my opinion the former and I will try to give some reasons for my standpoint.

We do not know so overwhelmingly much about the earlier history of the Cavicornia, but it seems safe to suppose that during a period immediately before the Pontian, or even at the beginning of the Pontian itself, this group suddenly exploded into the rich variety of forms, which we know from the Pontian deposits of Europe and Asia. In a large group represented by so different forms as *Sinotragus* and *Palaeoryx* the dentition is so similar that it seems to be absolutely impossible to base any kind of classification on it (BOHLIN 1935; I am quite conscious that the last 5 plates in this paper are rather superfluous, they were published in order to demonstrate the uniformity of the tooth material from different localities and with certainty belonging even to different genera). I take this as a guarantee for that the teeth are more conservative than the horn-cores. The plasticity of the horn-cores is also demonstrated by the Pontian Cavicornia from Samos, which show a disposition to acquire twisted horn-cores, evidently unmatched during the Pontian: even the very short horn-cores of *Parurmiatherium* have been influenced. I am therefore inclined to assume that the difference in the dentition in the Pontian *Gazellinae* counts more than a difference in the structure of the horn-cores.

However this may be, it seems to me rather unlikely that a certain similarity in the shape of the horn-cores and a similar complication (or lack of complication) in the P_4 would suffice to force forms with, for the rest, so different dentitions as *Gazella gaudryi* and *Gazella dorcadoides* together into one species.

Skull measurements.

	Gazella gaudryi type					*Gazella dorcadoides* type		
	Loc. 114S				Loc. 114N	Loc. 30	Loc. 43	Loc. 109
	Large	Small						
		1	2 ♀	3				
Length: Foramen magnum — P^2	(120)	(113)	111[1]	—	115	105	—	(115)
Postorbital length[2]	99	91	—	95	—	88	—	90
Foramen magnum to rear of palate in the middle	66	63	—	—	66	62	—	—
Breadth at the glenoidal fossae	(67)	—	—	—	—	73	—	2×38
Maximum breadth behind the orbits	84	86	—	(2×44)	—	90	—	(92)
Maximum temporal breadth	55	55	55	(51)	—	58	50	(61)
Height of the brain case[3]	52	41	40	(37)	—	49	36	41+
Breadth between the external meatus auditorii	63	(56)	51	48	—	54	(54)	55
Breadth of the condyles	39	36	38	36	—	(32)	30	32
Height of the occiput[4]	22	(19)	(19)	(19.5)	—	—	(19)	19
Orbits: Length	(37)	(34)	—	32, 28	—	30	—	35
Height	36	(25)	—	29, 24	—	31	—	28
Maxillary above M^3 — roof of orbits	59	46	—	—	—	52	—	51
Basal distance of horn-cores: externally	2×34	58	—	2×30	—	68	—	2×36
internally	2×12	23	—	2×12	—	30	—	2×19
Horn-cores: dimensions of cross-section at the base	30×22.5	21×18	—	21×17	—	22×18	—	20×16
Length of bullae	25	(18)[5]	19	19	28	(20)[5]	18	17
Height of bulla + meatus auditorius	35	—	25	28	—	—	28	27

[1] Length from occipital condyles to front edge of premaxillae 156 mm.

[2] From the lower lachrymal suture at the edge of the orbits to the tip of the condyles.

[3] From the skull base between the tubercula pharyngea to the middle of the parietals.

[4] From the posterior edge of the foramen magnum to the projection for the nuchal ligament.

[5] Distance: foramen lacerum posterius — foramen ovale.

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Explanation of the plates.

Plate I.

Fig. 1. *Cervocerus novorossiae.* P^4—M^3. Loc. 49.
Fig. 2. Upper teeth (P^3—M^3) of the *Gazella gaudryi* type. Loc. 109.
Fig. 3. Upper teeth (DP^4, P^4—M^3) of the *Gazella gaudryi* type. Loc. 114 S.
Fig. 4. Upper teeth (DP^2—M^3) of the *Gazella gaudryi* type. Loc. 78.
Fig. 5. Fragment of lower jaw with P_2—M_3. *Gazella gaudryi* type. Loc. 49.
Fig. 6. Fragment of lower jaw with P_2—M_3. *Gazella dorcadoides* type. Loc. 49.
Fig. 7. *Gazella paragutturosa.* DP^4, P^4—M^3. Loc. 64.
Fig. 8. Upper teeth (P^4—M^3) of the *Gazella dorcadoides* type. Loc. 30_5.
Fig. 9. Upper teeth (DP^4, P^4—M^3) of the *Gazella dorcadoides* type. ?Loc. 109.
Fig. 10. Upper teeth (DP^2—M^2) of the *Gazella dorcadoides* type. Loc. 30_5.
Fig. 11. *Gazella gaudryi.* DP^2—M^2 (same as 1935, Pl. X: 8 & 9). Loc. 73.
Fig. 12. *Gazella dorcadoides* type. P^3—M^3. Loc. 30_5.
Fig. 13. *Gazella dorcadoides* type. P^3—M^3. Loc. 114 S.

Plate II.

Fig. 1. *Gazella.* Lower jaw with P_4—M_3. Loc. 114 S.
Fig. 2. *Gazella gaudryi.* M_2 (same as 1935, Pl. X: 10). Loc. 73.
Fig. 3. *Gazella.* P_3—M_2. Loc. 49.
Fig. 4. *Gazella dorcadoides* type. M_1—M_3. Loc. 43.
Fig. 5. *Gazella dorcadoides* type. Lower jaw with P^4—M^3. Loc. 114 S.
Fig. 6. *Gazella* sp. Palate. Loc. 114 N.
Fig. 7. *Gazella.* M_3 and partial M_2. Loc. 114 N.
Fig. 8. *Gazella sp.* P_4, M_1 and partial M_2. Loc. 114 N.
Fig. 9. *Gazella.* Lower jaw with DP_2—M_3. Loc. 114 S.
Fig. 10. *Gazella dorcadoides* type. M_2 and M_3. Loc. 30_2.
Fig. 11. *Gazella dorcadoides* type. DP_3—M_2. Loc. 30_5.
Fig. 12. *Gazella dorcadoides* type. M_1 and M_2. Loc. 114 S.
Fig. 13. *Gazella dorcadoides* type. DP^3—M^2. Loc. 114 S.

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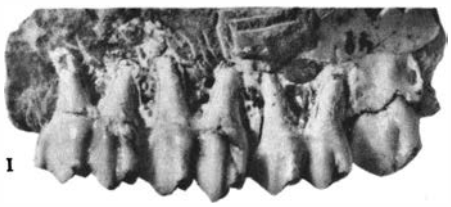
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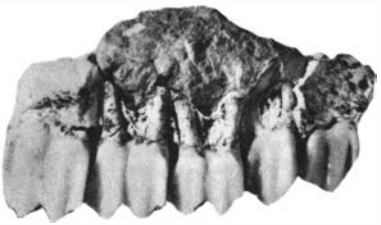
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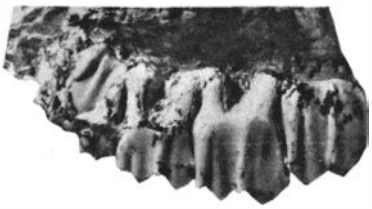
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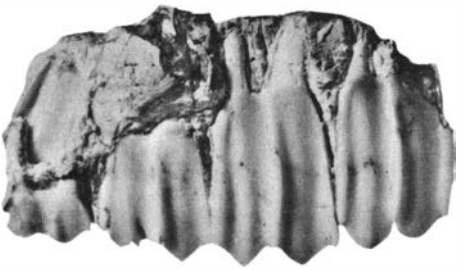
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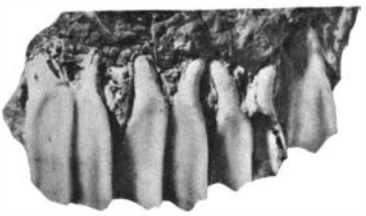
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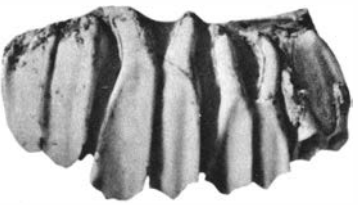
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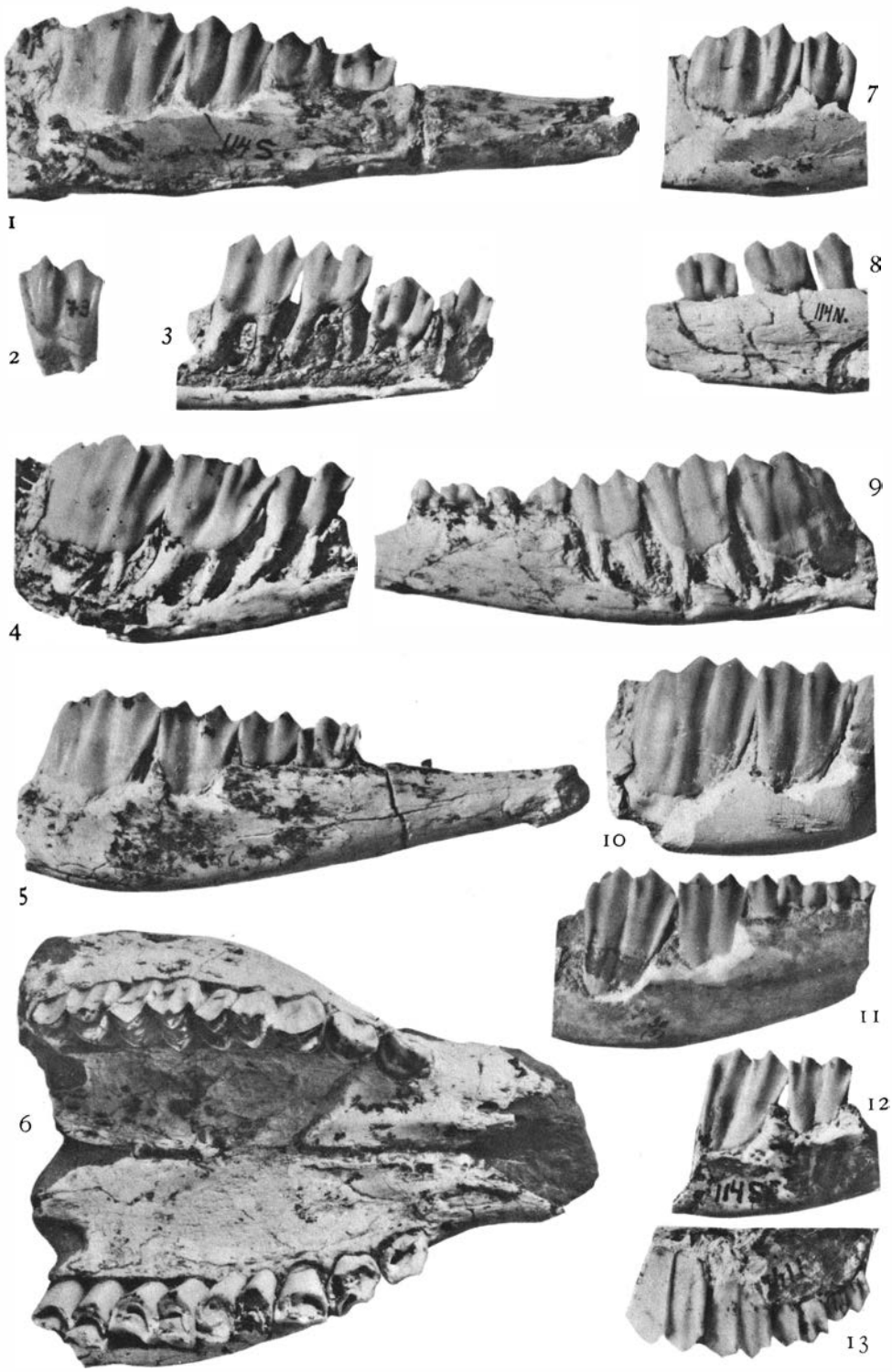
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