FURTHER STUDIES ON TWO SKELETONS OF THE BLACK RIGHT WHALE IN THE NORTH PACIFIC

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ABSTRACT

Two skeletons of the black right whale were studied, supplementing our previous report. In the skull, studied together with four specimens reported before, the proportional length of the rostrum increases and the rostrum becomes more curved downwards with age, whereas the skull breadth decreases its proportion slightly. The numbers of vertebrae of these specimens were erroneously reported in the previous paper, but now they are corrected. In one specimen the 1st dorsal vertebra united to the mass of cervicals. Sexual difference in the form and size of the pelvic bone is suggested.

In our previous paper (Omura *et al.* 1969) are also included the two black right whales taken in 1968 in the Okhotsk Sea. They are a male and a female of 15.20 and 12.60 m in length respectively (Whale nos. 68A and 68B). The skeletons of these whales had been burried for about two years in the sand of the beach at Mombetsu in Hokkaido, where the whales were processed. In July 1970 we dug out the bones from the sand and sent them to Taiji Whale Museum in Wakayama prefecture, after cleaning. In December of the same year we made observations and a series of measurements of the skeletons, and results of which are reported in the present paper. The specimen 68A is now being kept at the museum and the 68B specimen was sent to Landessammlungen für Naturkunde in Karlsruhe, West Germany, where it is planned to mount the skeleton for display.

The skull of the specimen 68A was broken into three major portions, i.e. the beak, and right and left cranial portions, and many small flagments, being hit at the time of taking by a harpoon. But the major broken parts are in such a good condition that the skull could be restored, and thus enabling us to make some of the series of the measurements. The skull of the specimen 68B is complete.

SKULL

The results of the skull measurements are shown in Appendix Table 1, together with the calculated percentages of each measurement against their skull length as well as those of skull breadth.

We have now the skull measurements for six specimens of the black right whale in the North Pacific as listed in Table 1, and some selected measurements of these specimens are compared in Fig. 1. As seen in Fig. 1 the smallest and the largest

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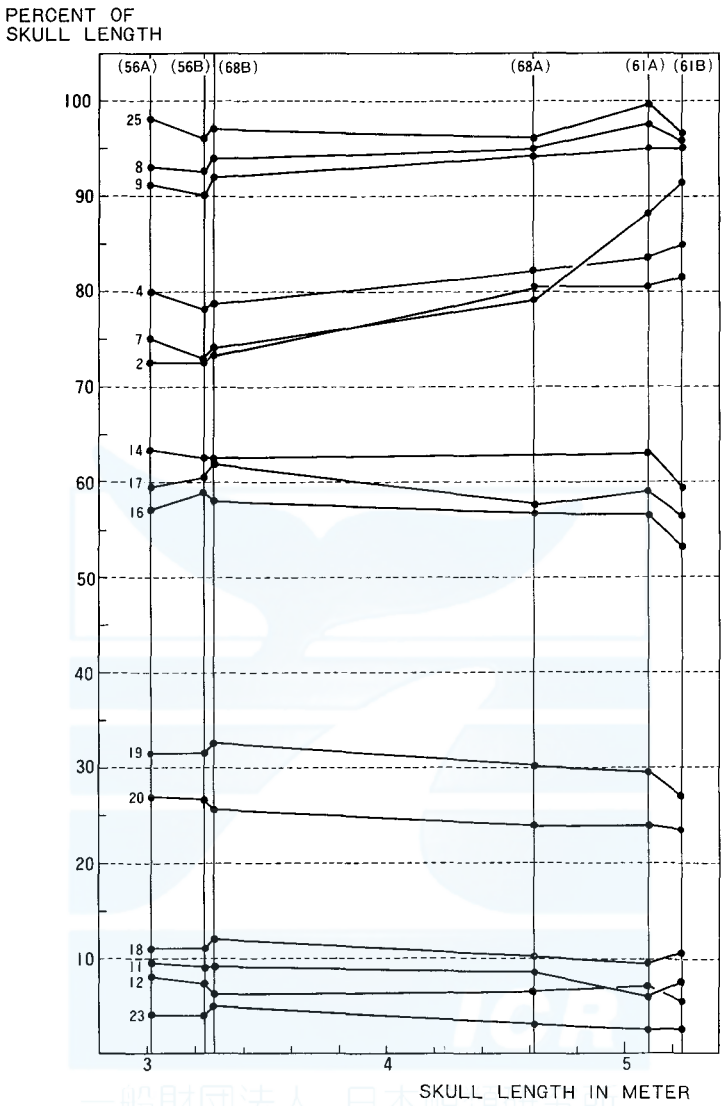

Fig. 1. Proportional growth of bones in the skull of the black right whale in the North Pacific. Numerals in the figure indicate measurement number in Appendix Table 1, but see also text.

skulls are those of the specimens 56A and 61B, being their lengths 3,022 and 5,240 mm respectively. The other four specimens are not distributed evenly between these lengths, but rather biassed towards the extremities. It is suggested from Fig. 1, however, some trends of the changes of the proportional lengths of various parts of the skull with the growth or age of the whale. These changes can be grouped into two categories.

TABLE 1. LIST OF THE SKULL SPECIMENS OF THE BLACK RIGHT WHALE IN THE NORTH PACIFIC USED FOR COMPARISON

Specimen no.	Body length	Sex	Skull length	Maturity	Author
	cm		mm		
56A	1,165	F	3,022	Sexually immature	Omura, 1958
56B	1,240	M	3,230	" "	" "
61A	1,710	M	5,100	Physically mature	Omura *et al.* 1969
61B	1,700	M	5,240	" "	" " "
68A	1,520	M	4,620	Sexually immature	Present paper
68B	1,260	F	3,270	" "	" "

1. Proportional length increases with the age.

In this category are included: length of maxillaries at superior border, straight (no. 2); length of premaxillaries, straight (no. 4); anterior end of nasals to end of rostrum, on curve (no. 7); length from tip of premaxillaries to posterior end of pterygoid (no. 8); and length from tip of premaxillaries to posterior end of palatines, medial (no. 9).

2. Proportional length decreases or practically no change with the age.

In this category are included: breadth of skull, orbits (no. 14); breadth of skull at orbital processes of maxillaries (no. 16); breadth of skull at squamosals (no. 17); greatest breadth of occipital bone (no. 19); height of supraoccipital bone, from foramen magnum (no. 20); breadth of rostrum at middle (no. 18); length of nasals (no. 11); breadth of two nasals distally (no. 12); greatest breadth of foramen magnum (no. 23); and length of mandible, straight (no. 25).

The measurements which belong to the first category are those concerned with the length of the beak or longitudinal growth of the facial region of the skull, and the measurements in the second category are mainly those concerned with the width or transverse growth of the skull. The proportional growth with age of the maxillaries and premaxillaries are very conspicuous, whereas the width of the skull at various parts stay fairly constant or show rather decrease. The proportional increase of the curved length from the anterior end of nasals to end of rostrum is quite striking. This may be attributable to the fact that the proportional size of the nasals decreases slightly with age, but it is also possible that the beak itself becomes more curved downwards. The proportions of the greatest breadth of the occipital bone and the height of the supraoccipital bone decrease slightly with age. In the breadth of the foramen magnum is shown also similar trend.

Practically no change is observed in the percentage length of mandible in relation to age.

VERTEBRA

The numbers of vertebrae were erroneously reported in the previous paper (Omura *et al.* 1969) in Table 30 as having 57 and 55 vertebrae respectively. These numbers were counted at the time of dismembering of the whale carcasses when some meat and other soft parts still attached on the surface of bones. These numbers are now

corrected as follows:

68A. C 7, D 14, L 10, Ca 27, Total 58.
68B. C 7, D 14, L 10, Ca 26, Total 57.

In the specimen 68A epiphyses are only fused to the centra in the caudal region from 13th caudal onwards except the last three which are not united. From a histological examination of the testes this whale was assigned as immature (Omura *et al.* 1969), but it is possible that the whale was at the stage of approaching puberty, judged from the weights of testes. In the specimen 68B none of the epiphyses united to their centra.

The most interesting feature of these vertebrae is that of the cervicals of the specimen 68A. In this specimen the centrum of the first dorsal vertebra has completely fused to the united mass of cervicals, making an appearance as if this is the last cervical and in this specimen there present eight cervicals, as shown in Fig. 2. But it has transverse processes of not differing from other specimens, and it is possible

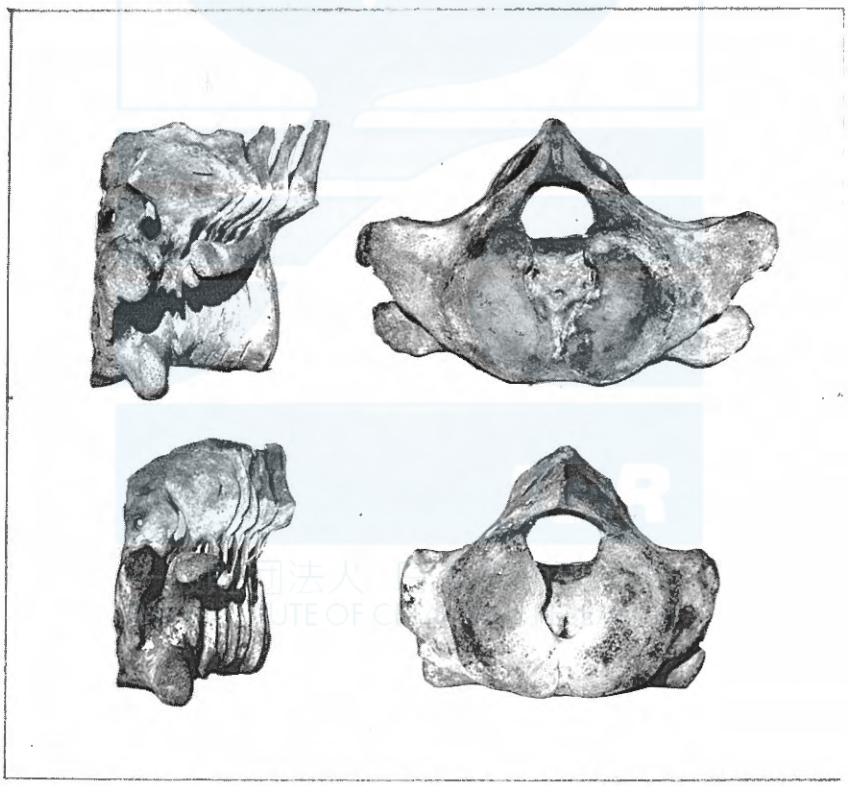

Fig. 2. Cervicals of the black right whale in the North Pacific.
Upper: specimen 68 A. In this specimen the 1st dorsal vertebra has fused to the mass of cervicals.
Lower: specimen 68 B.
Left: lateral view. Right: frontal view.

that the first ribs articulate at these processes. In the specimen 68B, only seven cervicals united into a mass of bones as usual.
Measurements of each vertebra are shown in Appendix Table 2 for the both specimens.

RIBS AND STERNUM

In the specimen 68A fourteen pairs of ribs are present. But in the 68B there present one small rib in addition to fourteen pairs. This rib is small and slender, and its length is only about a half of the preceeding one and rudimental. On the transverse processes of the 22nd vertebra there are no trace of facet for articulation of rib. Thus we assigned the number of dorsal vertebrae as fourteen and that of lumbar ten as stated before, but if we count fifteen dorsals then the number of lumbars becomes nine. In any case the total number of vertebrae is the same. The straight lengths of ribs are shown in Table 2.

TABLE 2. STRAIGHT LENGTH OF RIBS OF THE SPECIMENS 68A AND 68B (in mm)

	68A		68B	
Rib no.	Right	Left	Right	Left
1	1,375	1,335	790	680+*
2	1,715	1,740	1,195	1,095
3	1,805	1,810	1,480	1,465
4	1,910	2.000	1,615	1,600
5	2.010	2,070+*	1,690	1,675
6	2,105	1,950+*	1,755	1,740
7	2,095	2,090	1,830	1,795
8	2,050	2,010	1,755	1,730
9	1,920+*	1,940+*	1,675	1,655
10	1,900	1,860+*	1,645	1,565
11	1,785	1,805	1,555	1,550
12	1,665	1,690	1,505	1,495
13	1,525	1,510	1,320	1,325
14	930	975	1,135	1,160
15	—	—	—	500

* Partly broken.

The sternum of the specimen 68B was missed at the time of treating the carcass, and that of 68A is 510 mm long and 381 mm width with no special feature.

PELVIC BONE AND FEMUR

Pelvic bones of these two specimens are of some interest, suggesting a sexual difference in the form and size (Fig. 3). The bones of the male specimen 68A are quite similar to those of the specimens 61A and 61B, both male, as reported by Omura *et al.* (1969). The length and the breadth at tuberculum laterale of the right and left bones are 447, 83 and 440, 76 mm respectively. On the other hand in the female

specimen 68B the form is different and the length is much shorter in relation to its breadth. The corresponding figures of the right and left bones are 207, 67 and 201, 55 mm respectively. Further the angle between the cranial and caudal processes is greater in 68A than in 68B. Hosokawa (1951) found a marked sexual difference in the form of pelvis in the fin and blue foetuses. Jonsgård (1970) has also reports that the pelvic bone may be useful for sex determination, and perhaps also for age determination of the minke whale in the North Atlantic.

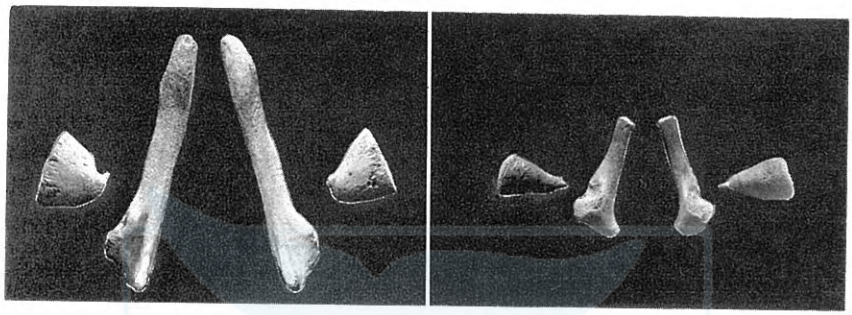

Fig. 3. Pelvic bones (inner) and femur (outer) of the black right whale in the North Pacific.
Left: specimen 68 A (male). Right: specimen 68 B (female).

The femur too somewhat different between the two specimens. The lengths and breadths of the right and left bones of the 68A are 106, 123 and 107, 129 mm respectively, but in the 68B the bones are much longer and more pointed. The corresponding figures in this specimen are 115, 77 and 123, 75 mm. In both specimens the femur is very light and has a sponge-like structure and not differs from that of the specimens 61A and 61B in this respect.

HYOID BONE

Hyoid bones of the both two specimens are of no special feature, except that in the combined bone of basihyal and thyrohyals of the specimen 68B. In this bone the basihyal has not been fused completely with left thyrohyal and the suture is very loose. Omura (1958) reports also in the specimen 56B the sutures are still visible though these bones are united completely. Measurements of hyoid bones are shown in Table 3.

TABLE 3. MEASUREMENTS OF HYOID BONES OF THE SPECIMENS 68A AND 68B (in mm)

Measurements	68A	68B
Straight length	744	578
Height at middle	165	98
Length of stylohyal R.	379	256
„ „ L.	389	263

SCAPULA, HUMERUS, RADIUS, AND ULNA

The bones are of no special feature and measurements of these bones are shown in Table 4.

TABLE 4. MEASUREMENTS OF SCAPULA, HUMERUS, RADIUS, AND ULNA OF THE SPECIMENS 68A AND 68B (in mm)

	68A		68B	
	Right	Left	Right	Left
Scapula				
Breadth	1,152	1,129	942	936
Height	948	933	764	747
Humerus				
Length	628	629	523	520
Breadth at middle	264	261	238	229
Radius				
Length	674	678	571	580
Breadth at middle	243	234	172	161
Ulna				
Length at middle	536	524	459	465
Breadth at middle	124	119	98	98

CARPALS AND PHALANGES

Each five carpals were saved from right and left flippers of the both specimens. The phalangeal formulae for the specimens 68A and 68B are I_3, II_5, III_6, IV_4, V_4 and I_2, II_5, III_5, IV_4, V_4 respectively.

CHEVRON BONE

Thirteen chevron bones were preserved from the specimen 68A. Among these the 1st, 12th, and 13th are not united of the right and left laminae. For the 68B specimen are present twelve chevrons and in which 1st, 2nd, 11th, and 12th are not united.

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APPENDIX TABLE 1. SKULL MEASUREMENTS OF THE BLACK RIGHT WHAIE IN THE NORTH PACIFIC

Measurements		68A in mm	68A % of length	68A % of breadth	68B in mm	68B % of length	68B % of breadth
1. Length of skull, straight		4,620	100.0	159.8	3,270	100.0	161.7
2. Length of max. at superior border, straight		3,710	80.3	139.2	2,425	74.2	119.9
3. Length of max., following curve of sup. external border		3,865	83.7	145.0	2,520	77.1	124.6
4. Length of premax., straight		—	—	—	2,567	78.5	127.0
5. Length of premax., along dorsal convexity		4,045	87.6	151.8	2,675	81.8	132.3
6. Length of rostrum, straight		—	—	—	2,516	76.9	124.4
7. Anterior end of nasals to end of rostrum, on curve		3,650	79.0	137.0	2,410	73.7	119.2
8. Length from tip of premax. to posterior end of pterygoid		4,380	94.8	164.4	3,080	94.2	152.3
9. Length from tip of premax. to post. end of palatines, median		—	—	—	3,020	92.4	149.4
10. Length from tip of premax. to ant. end of palatines, median		—	—	—	2,610	79.8	129.1
11. Length of nasals, median		391	8.5	14.7	295	9.0	14.6
12. Breadth of 2 nasals distally		308	6.7	11.6	197	6.0	9.7
13. Breadth of 2 nasals proximally		276	6.0	10.4	287	8.8	14.2
14. Breadth of skull, orbits		—	—	—	2,038	62.3	100.8
15. Breadth of skull at ant. and dist. ends of orbital process of frontal		—	—	—	2,121	64.9	104.9
16. Breadth of skull at orbital processes of maxillaries		—	—	—	1,904	58.2	94.2
17. Breadth of skull at squamosals		2,665	57.7	100.0	2,022	61.8	100.0
18. Breadth of rostrum at middle, straight		—	—	—	391	12.0	19.3
19. Greatest breadth of occipital bone		1,392	30.1	52.2	1,061	32.5	52.5
20. Height of supraoccipital bone, from foramen magnum		1,112	24.1	41.7	836	25.6	41.3
21. Transverse breadth of occipital condyles		353	7.6	13.2	370	11.3	18.3
22. Height of occipital condyle	R	288	6.2	10.8	304	9.3	15.0
	L	285	6.2	10.7	305	9.3	15.1
23. Greatest breadth of foramen magnum		129	2.8	4.8	109	3.3	5.4
24. Greatest height of foramen magnum		145	3.1	5.4	161	4.9	8.0
25. Length of mandible, straight	R	4,460	96.5	167.4	3,180	97.3	157.3
	L	4,425	95.8	166.0	3,185	97.4	157.5
26. Length of mandible, on curve	R	4,775	103.4	179.2	3,395	103.8	167.9
	L	4,675	101.2	175.4	3,370	103.1	166.7
27. Depth of mandible at coronoid	R	468	10.1	17.6	381	11.7	18.8
	L	463	10.0	17.4	373	11.4	18.4
28. Depth of mandible at condyle	R	502	10.9	18.8	378	11.6	18.7
	L	490	10.6	18.4	387	11.8	19.1

APPENDIX TABLE 2. MEASUREMENTS OF VERTEBRAE OF THE BLACK RIGHT WHALE IN THE NORTH PACIFIC (in mm)

1. Specimen 68A

Serial no.	Vertebral no.	Greatest breadth	Greatest height	Centrum Breadth	Centrum Height	Centrum Length	Note
1	C 1						
2	2						
3	3						
4	4	789	502			248	
5	5						
6	6						
7	7						
8	D 1	685	518	307	250	67	Fused to cervicals
9	2	694	529	296	251	88	
10	3	692	564	281	240	101	
11	4	664	593	275	237	117	
12	5	623	604	276	236	125	
13	6	617	598	277	235	133	
14	7	625	604	280	236	141	
15	8	624	616	287	239	155	
16	9	668	623	304	240	169	
17	10	692	622	322	244	181	
18	11	694*	620	313	244	170	* Estimated
19	12	746	626	345	248	185	
20	13	818	626	335	248	193	
21	14	947	647	340	255	203	
22	L 1	1,039	665	337	274	206	
23	2	1,104	681	339	285	210	
24	3	1,114	—**	338	288	215	** Spinous process broken
25	4	1,119	701	338	294	217	
26	5	1,121	732	342	309	225	
27	6	1,128	720	346	305	229	
28	7	1,122	739	344	304	236	
29	8	1,111	714	351	312	239	
30	9	1,041	718	360	323	240	
31	10	1,081	699	359	312	241	
32	Ca 1	983	702	367	343	242	
33	2	933	671	364	347	245	
34	3	867	669	354	354	240	
35	4	786	—**	350	351	241	** Spinous process broken
36	5	689	630	354	356	238	
37	6	606	608	346	361	234	
38	7	570	580	352	364	232	
39	8	511	568	346	355	232	Incomplete foramen on t. process
40	9	478	545	351	354	221	T. processes perforated.
41	10	436	518	346	352	216	
42	11	398	482	342	345	205	
43	12	366	451	340	337	198	
44	13	347	405	325	328	185	T. process ends

Continued . . .

APPENDIX TABLE 2. Continued.

1. Specimen 68A

Serial no.	Vertebral no.	Greatest breadth	Greatest height	Centrum			Note
				Breadth	Height	Length	
45	14	332	365	301	304	171	Epiphyses fused to centra from 13 th caudal, except last 3
46	15	299	315	282	275	147	
47	16	—	—	257	247	132	Neural canal disappear
48	17	—	—	216	205	123	
49	18	—	—	194	185	115	
50	19	—	—	172	172	108	
51	20	—	—	162	157	103	
52	21	—	—	138	139	93	
53	22	—	—	122	123	82	
54	23	—	—	102	103	71	
55	24	—	—	85	83	63	
56	25	—	—	65	63	55	
57	26	—	—	45	47	47	
58	27	—	—	30	30	24	

2. Specimen 68B

Serial no.	Vertebral no.	Greatest breadth	Greatest height	Centrum			Note
				Breadth	Height	Length	
1	C 1						
2	2						
3	3	600	451			213	
4	4						
5	5						
6	6						
7	7	273	464	273	223	41	
8	D 1	484	460	269	224	78	
9	2	620	459	285	220	72	
10	3	466	471	271	218	99	
11	4	445	494	249	214	113	
12	5	495	514	250	210	122	
13	6	484	520	249	210	129	
14	7	482	517	256	210	140	
15	8	478	519	258	214	149	
16	9	490	516	267	216	161	
17	10	496	510	274	216	165	
18	11	538	507	290	214	168	
19	12	568	489	309	217	172	
20	13	631	489	313	215	177	
21	14	714	486	317	216	180	
22	L 1	750	503	299	225	182	
23	2	727	526	295	239	189	
24	3	718	544	293	251	188	
25	4	703	564	292	264	199	
26	5	758	565	295	272	202	

Continued . . .

APPENDIX TABLE 2. Continued.

2. Specimen 68B

Serial no.	Vertebral no.	Greatest breadth	Greatest height	Centrum			Note
				Breadth	Height	Length	
27	6	750	552	298	263	279	
28	7	725	577	293	266	205	
29	8	718	562	293	258	211	
30	9	716	570	304	282	226	
31	10	693	567	305	282	227	
32	Ca 1	674	567	309	295	235	
33	2	643	555	312	291	235	
34	3	617	561	314	299	237	
35	4	585	553	314	306	235	
36	5	560	557	315	314	236	
37	6	520	535	319	328	237	
38	7	496	534	321	334	236	Foramen on left t. process
39	8	461	517	324	334	233	Both t. processes perforated
40	9	418	503	339	333	229	
41	10	387	475	327	335	222	
42	11	360	452	338	332	219	
43	12	337	418	324	318	203	T. processes end
44	13	—	382	312	305	196	
45	14	—	326	300	272	181	
46	15	—	—	259	246	151	Neural canal disappear
47	16	—	—	231	223	128	
48	17	—	—	194	191	117	
49	18	—	—	173	171	109	
50	19	—	—	161	157	105	
51	20	—	—	152	143	95	
52	21	—	—	131	127	87	
53	22	—	—	115	107	75	
54	23	—	—	102	89	65	
55	24	—	—	84	70	56	
56	25	—	—	61	53	57	
57	26	—	—	39	38	31	