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Effect of Visual Impulses Upon Progression and Righting of the Crayfish.

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In the course of our systematic study of body righting in the crayfish, *Cambarus virilis, Hagen,* we observed the following phenomena. Extirpation of both eyes, including the eyestalks, causes the animals to lose permanently their ability to walk forward. A normal crayfish occasionally walks backward, but its usual mode of progression on land is forward. In a large number of crayfish operated upon we never observed any forward movement after the operation. A similar effect may be produced temporarily by merely blindfolding the animal.

Immediately after removal of the eyes the animals cannot turn over when placed on their back, but after a few days some of the operated animals regain their ability to right themselves from the dorsal position.

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Sex Differences in the Contraction Rate of the Human Gall Bladder.

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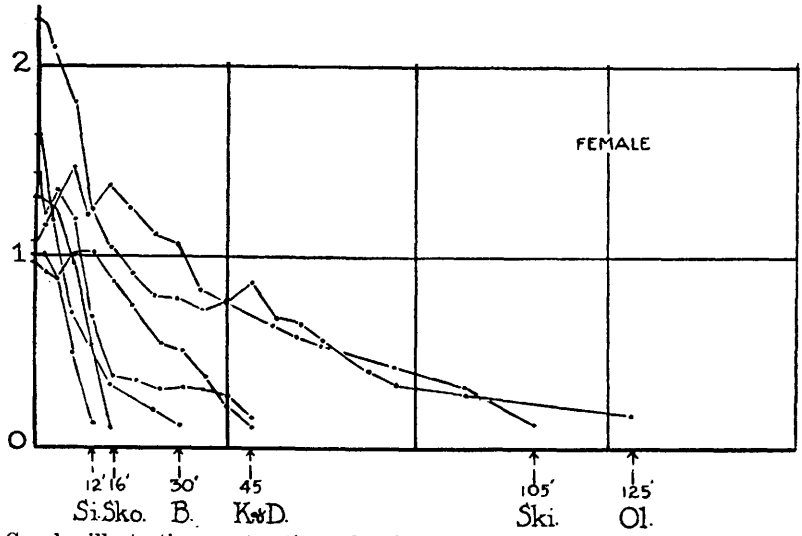
It is generally recognized by practitioners that certain disturbances of the biliary tract are more prevalent among women than among men, especially stout women. The reason for this difference has never been ascertained. Indeed, before the advent of the Graham method no adequate means existed of comparing either the size of this organ or its behavior in the two sexes. In the hope of finding some anatomical or physiological basis for clinical differences the writer has recently begun a study of the contraction of the gall bladder in healthy young women, following a standard meal of 5 egg-yolks and half a pint of cream.

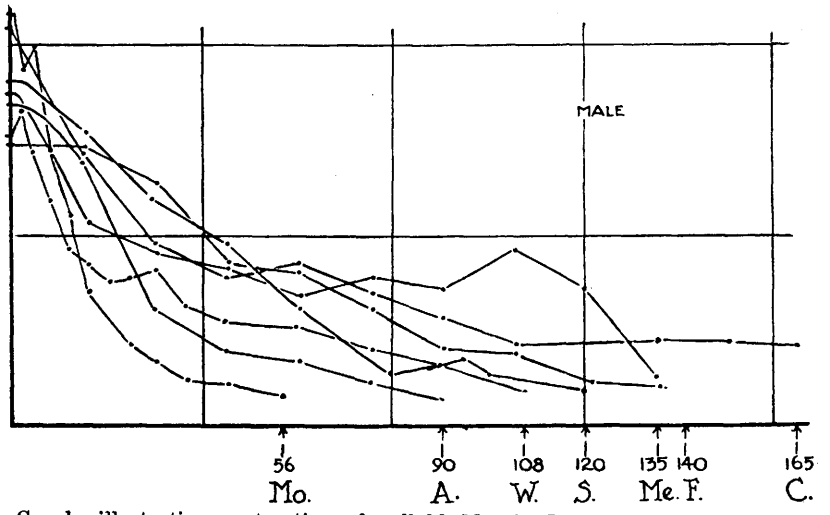
In 7 of these 11 cases it was possible to follow the contraction of the gall bladder until the shadow became very small. The changing

FIG. 1.



Graphs illustrating contraction of gall bladder in 7 young women following a meal of 5 egg-yolks and half a pint of cream. Volumes computed from cholecystograms.[1] *Abscissas* represent time in minutes (40 minutes to a square); *ordinates*, cubic inches of bile. 12', 16', etc., number of minutes required for the gall bladder to reach a volume of 0.18 cu. in. (3 cc.). *Letters* refer to names in Table I A.

FIG. 2.



Graphs illustrating contraction of gall bladder in 7 young men (Table I B), following a meal of 5 egg-yolks and half a pint of cream. 56', 90', etc, number of minutes required for the gall bladder to reach a volume of 0.18 cu. in. (3 cc.). *Letters* refer to names in Table I B.

volume of each series was then computed (Table I A) and contraction curves plotted. As these 7 young women were medical students or laboratory assistants, they belong to the same occupational group, therefore, as the young men previously studied.* A comparison of the two groups (Figs. 1 and 2) shows that the female gall bladder, instead of being more sluggish as might well have been predicted, empties faster than the male, 5 out of 7 cases reaching a very low volume of 3 cc. (0.18 cu. in.) in from 12 to 45 minutes after a meal; whereas 6 of the male gall bladders required over 90 minutes to reach the same low point.

This striking contrast is due neither to a differing latent period (the initial contraction in either sex occurring anywhere from 2 to 16 minutes after food enters the mouth), nor to the fact that the gall bladder of the male is usually larger and therefore has more bile to be expelled. For a comparison of the minimum time required in each sex for the discharge of 1 cu. in. of bile (16.4 cc.), shows that the female gall bladder is nearly twice as quick as the male, the average ratio in these 14 cases being 23:40 (Table I C). Equally instructive is a comparison of the total volume of bile discharged in the two sexes at the end of the first 15, 30, and 45 minute periods, the comparison again favoring the female gall bladder. One may, therefore, infer, provided these figures are supported by a larger number of cases, that the initial digestion and absorption of such foods as egg-yolk and cream take place more rapidly in young women than in young men.

Another significant feature in this comparison of the two sexes is the difference in size of the distended gall bladders per unit weight. Thus in Table II, it is shown that there is 1 cc. of bladder bile for every 3 1/3 pounds of body weight in the young men, but only 1 cc. to every 4 3/4 pounds in the young women. It would thus appear that in respect to size, the female gall bladder is at a disadvantage, especially if toward middle age the body increases greatly in weight, as in fleshy women. This may be offset, perhaps, by the quicker emptying time, so long as that function is unimpaired. An especially interesting case, from this standpoint, is the one shown at *C* in figure 4. In this individual the small gall bladder empties in the first 12 minutes after a meal, partially refills in the next 48 minutes, and then empties again within 40 minutes.

* Altogether, eight male series with egg-yolk and cream as a diet, have been completed by the writer. One of the eight (H. M. T.) has purposely been omitted from this paper since the gall bladder of this individual is much larger than the others and requires 4½ hours to empty.[1] The remaining seven (Fig. 2. Table I B) form a homogeneous group.

TABLE I.

Discharge of bile from human gall bladder after a meal of egg-yolk and cream.

A. In seven young women.

Name	Age	Wt.	Vol. G.B. before meal	Total discharge of bile			Minimum time required to discharge	
				15'pc.	30'	45'	1 cu. in. (16.4 cc.)	All but 3 cc.
		lbs.	cu. in.	cu. in	cu. in.	cu. in	min.	min.
C. L. B.	29	115	1.66	1.31	1.50	1.50	9.5	30
F. E. D.	18	120	1.03	.16	0.53	0.86	44.	45
R. Sko	34	121	1.30	1.19	1.22	1.22	9.5	16
S. M. O.	24	122	2.21	1.15	1.43	1.49	10.5	125
C. H. Si	29	135	1.26	1.06	1.13	1.16	12.	14
H.H. Ski	28	155	1.47	.09	0.40	0.75	64.	105
H. H. K.	23	190	1.44	1.05	1.11	1.26	12.	45
Totals	185	958	10.37	6.01 (98.6 cc.)	7.32 (120 cc.)	8.24 (135.1 cc.)	160.5	380

B. In seven young men.

		lbs.	cu. in.	cu. in.	cu. in.	cu. in	min.	min.
R.L. W.†	24	112	1.66	0.81	0.90	1.09	34.	108
E. F. S.*	29	142	1.81	0.27	0.63	0.86	48.	120
V. Me.	28†	142‡	1.75	0.67	0.85	0.93	58.	135 (5¾ cc.)
C. E. F.*	26	150	1.49	.01	0.20	0.62	80.	140
B. J. A.*	31	154	1.68	.28	1.05	1.27	24.	90
C. C. C.*	26	160	2.10	.66	1.20	1.32	24.	105 (7 cc.)
L.O.Mo†	26	175	2.14	1.44	1.81	1.91	11.	56
Totals	190	1038	12.63	4.14 (67.9 cc.)	6.64 (108.9 cc.)	8.00 (131.2 cc.)	279.	754

C. Comparison of averages in two sexes.

Sex	Age	Wt.	Initial volume of bile	Total discharge of bile			Minimum time required to discharge	
				at 15' pc.	at 30'	at 45'	1 cu. in. (16.4 cc.)	All but 3 cc.
		lbs.	cc.	cc.	cc.	cc.	min.	min.
Average for 7 women	27—	137	24.3	14.1	17.1	19.3	23.	54
Average for 7 men	27+	148	29.5	9.7	15.5	18.7	40.	108

* For complete data, see earlier paper.[1]

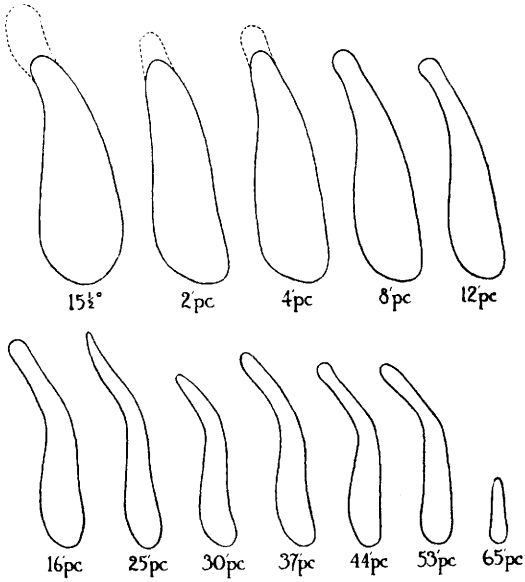
† For effect of diet of milk or cream alone on these same individuals, see previous paper.[2]

‡ Estimated.

As regards individual comparisons, the most striking examples are shown in figure 4. Here are two healthy individuals of comparable age and weight, with gall bladders of the same shape and

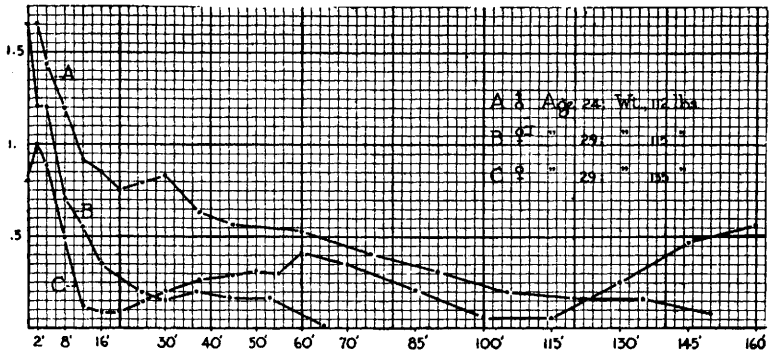
size at the beginning of experiment. That of the young woman (B) expels all but 3 of its 27 cc. of bile in the first half hour; that of

FIG. 3.



Tracings of cholecystograms showing typical contraction of gall bladder in a young woman (Dr. C. L. Birch). X 2/5. Volumes recorded in graph B, figure 4. 15½, 15½ hours after oral administration of tetraiodo-phenolphthalein; *2pc'*, 2 minutes after ingestion of egg-yolk and cream. *Dash line*, neck of gall bladder. Note change in shape following ingestion of food.

FIG. 4.



Graphs *A* and *B* (R. L. W. and C. L. B.) afford comparison of the contraction time of 2 gall bladders of the same size and shape, from individuals of the same weight but opposite sex. Graph *C*—Contraction curve of gall bladder in C. H. S. (Table I A), showing 2 successive emptyings within 1 hour and 40 minutes after a meal of egg-yolk and cream.

the young man (A) requires nearly four times as long (108 minutes) to discharge the same amount of bile. These graphs should also be compared with that of B. J. A. (Fig. 2; also Figs. 5 and 7 of a previous paper[1]), who required three times as long (90 minutes) starting with a gall bladder of the same shape and size as the one at B.

TABLE II.
*Volume of Distended Gall Bladder.**

No. cases	Average age	Average wt.	Average vol.	Ratio of bladder bile to body weight.
		lbs.	cu. in.	
A. Students X-rayed by the writer.				
9 men	28—	149	2.72	1 cc.: 3 1/3 lbs.
9 women	26+	136	1.73	1 cc.: 4 3/4 lbs.
B. Dispensary patients.†				
5 men	40—	144	2.4	1 cc.: 3 3/5 lbs.
7 women	36—	119	1.45	1 cc.: 5 lbs.

* Volume of fundus, body and infundibulum of gall bladder during fasting, computed by methods described in earlier paper.[1]

† From cholecystograms obtained through the courtesy of Doctor Hartung.

In conclusion, one may say that no satisfactory explanation of these sex differences is at present available. Conceivably, the female gall bladder may possess a more powerful *tunica muscularis*. It seems more likely, however, that it is not different in structure, but is merely differently timed to meet the needs of digestion. The degree of contraction depends, for instance, upon the behavior of the *sphincter papillae*, the rate at which fatty foods leave the stomach, etc. Yet I am informed by competent physiologists that no sex differences of this sort have ever been observed. Perhaps the explanation will be forthcoming when we know more about the effect on the gall bladder of such conditions as acid stomach, chronic constipation and intestinal obstruction, a phase of the problem which is now under investigation.

[1] Boyden, E. A., *Anat. Rec.*, 1926, xxxiii, 201-256.

[2] Boyden, E. A., PROC. SOC. EXP. BIOL. AND MED., 1926, xxiv, 157-162.