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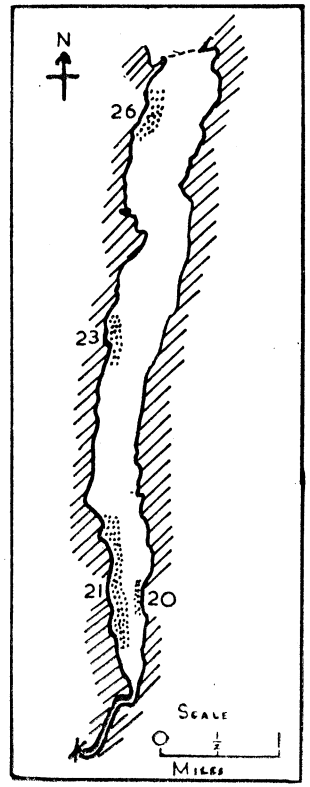
THE BREEDING HABITS OF TOADS (*BUFO BUFO*) IN LAKE WINDERMERE

By

J. F. D. FRAZER

Macan and Worthington (1951) recorded that toads (*Bufo bufo*) were taken in the perch traps in Lake Windermere, even at a depth of twenty feet, these toads being paired. It was decided to investigate this occurrence, and a correspondence was started with Dr. Macan. From this it became apparent that the toads were not only breeding in deep water, but that this was taking place in the month of May, which seemed exceptionally late.

Before giving an account of the records from Windermere, it is perhaps best to consider the way in which these were obtained. The toads were all



Rough map of the South basin of Lake Windermere, to show the trapping beats where toads were found.

taken in perch traps, which were first laid in the lake in 1940. These traps were placed on the bottom of the lake during the season when the perch entered relatively shallow water to spawn; this was a six week period from late April to early June. The traps were only visited and emptied once a week, and were gradually moved into shallower water as the perch moved in. Until 1952, there was no idea that the catching of breeding toads in the traps was anything unusual, so that they were only recorded spasmodically by the fishermen. In 1952, systematic records were made, so that no haul of toads went unrecorded. In all cases, toads taken were emptied from the traps back into the water.

Examination of the actual notebooks kept by the fishermen showed that the toads were only taken in certain parts of the lake. The sections concerned are shown in the map: of the various areas fished, toads were only recorded from beat 20 on the East side of the lake and from beats 23 and 26 on the West side of the lake, apart from occasional single toads in beat 21. This beat is opposite beat 20, and it seems probable that these were stragglers from the latter beat. Records obtained from these beats are given in Table 1.

TABLE 1

Records of Toads Trapped

Beat 20.

1947. 20 traps at 20 feet. 20 toads on May 13th. None a week earlier or later.
1948. April 28th, 20 traps at 20 feet, 39 toads. May 3rd, 20 traps at 18 feet, 8 toads.
1949. April 27th, 18 traps at 20 feet, 17 toads. May 4th, 18 traps at 18 feet, 12 toads.
1950 and 1951. No toads recorded.
1952. April 28th, 20 traps at 15 feet. 14 toads in amplexus in 2 traps. Also spawn.
May 5th, 4 toads in two traps. No spawn.
May 12th, 1 toad. No spawn.

Beat 21.

1948. May 17th, 1 toad at 15 feet.

Beat 22.

1948. 20 traps at 20 feet.
April 27th, 2 toads.
May 3rd, 1 toad.

Beat 23.

1943. 30 traps at 11 feet. "A quantity of frogs in traps" on April 30th. None on 27th or May 3rd.
1944. 20 traps at 20 feet. "One trap full of frogs" on May 1st. None on April 27th or May 4th.

1948. April 27th, 17 traps at 20 feet, 65 toads.
May 3rd, 20 traps at 18-20 feet, 5 toads.
May 10th, 20 traps at 15 feet, 0 toads.
May 18th, 18 traps at 15 feet, 1 toad.
1949. April 27th, 19 traps at 20 feet, 250 toads.
May 4th, 19 traps at 18 feet, 0 toads.
May 12th, 19 traps at 15 feet, 60 toads.
1950. No toads recorded.
1951. May 10th, 20 traps at 15 feet, "Toads!"
1952. April 29th, 10 toads in 3 traps (in amplexus). Also spawn. 20 traps at 15 feet.
May 7th, 2 toads in one trap, with spawn. 15 feet.

Beat 26.

1943. April 30th, 30 traps at 11 feet, "A quantity of frogs in traps."
1948. April 27th, 25 traps at 20 feet, 5 toads.
1949. April 27th, 23 traps at 20 feet, 4 toads.
May 5th, 23 traps at 18 feet, 12 toads.
1950. No toads recorded.
1951. April 30th, 25 traps at 17 feet, "Several toads" at North end of beat.
1952. April 28th, 4 toads in 3 traps (one pair with spawn). 25 traps at 12-16 feet.
May 6th, 3 toads in 2 traps, 15 feet.

TABLE 2

Temperatures recorded in Lake Windermere

1947.

Depth	7.5.47	14.5.47	21.5.47
0	7.55	10.65	12.15
1	—	10.5	11.35
2	7.0	—	—
3	—	9.0	10.95
5	6.9	7.8	10.2
7	—	7.7	9.4
10	6.75	7.2	8.4
12	—	—	7.6
15	—	6.8	6.6
20	6.66	6.55	—
25	—	—	6.5
32	—	6.4	—
33.5	—	—	6.4
37	6.2	—	—

1948.

Depth	21.4.48	26.4.48	4.5.48	15.5.48
0	8.0	9.85	9.2	12.7
2	7.95	9.6	—	—
3	—	—	—	12.7
4	7.85	9.4	—	12.4
4.5	—	—	—	10.6
5.5	—	—	—	10.5
6	7.75	9.0	—	—
6.5	—	—	—	10.3
8	7.6	—	—	10.1
9	—	—	—	10.1

Depth	21.4.48	26.4.48	4.5.48	15.5.48
10	7.45	8.45	9.1	9.6
12	—	—	—	9.2
13	—	—	9.0	8.9
14	—	—	8.8	8.7
15	7.1	8.2	8.1	8.0
17	—	—	7.8	8.0
18	—	—	—	7.7
20	6.85	7.6	7.5	7.5
24	—	—	—	7.3
33	6.6	7.0	7.2	—

1949.

Depth	28.4.49	3.5.49	10.5.49	17.5.49
0	9.5	10.2	12.0	12.6
2	—	9.2	—	—
4	—	—	—	12.4
5	—	8.7	—	12.0
7	—	—	—	11.5
8	—	—	—	10.7
10	—	8.1	—	—
12	—	—	—	10.0
15	—	7.4	—	9.4
17	—	—	—	9.0
20	—	7.1	—	8.7
24	—	—	—	8.4
25	—	—	8.4	—
34	—	—	8.1	—

From 1947 to 1949, temperatures were recorded at different depths in the centre of the South basin of the lake, and in 1951 at the surface and at 32 feet: no temperatures were recorded from the actual sites of the traps. The relevant temperatures are given in Table 2. The 1951 temperatures (at the surface and 32 feet respectively) were (April 23rd) 6.4° and 5.4°, (April 30th) 6.1° and 5.8°, (May 7th)6.7° and 6.7°, (May 15th) 9.1° and 7.0°. In 1952, temperatures at fifteen feet depth were (April 28th) 8.0° (May 5th) 8.5° and (May 12th) 9.0°C.

It will be seen from Table 1 that "frogs" were recorded in 1943 and 1944. The records on these three occasions were all from the same fisherman, and it seems possible that he was mistaking toads for frogs. This becomes even more likely when it is noticed that he only recorded frogs from the two beats where toads have been subsequently found in the greatest numbers. It will be noticed that the numbers fluctuate from year to year. The toads are only found in certain specific spots. For example, only one (in 1953, at 12 feet depth) has ever been taken in the northern half of the lake. The places of finding appear to be the actual spawn sites, or else very near to these. The traps have usually been set about 20 yards from land, on a steeply shelving shore, toads not being found in those farther out. At about the time that toads are caught in the traps, large numbers have been noted (K. Shepherd) crossing the road just above Beat 26. There has been no evidence to suggest that the toads might have hibernated in the lake. In fact, it has been stated that the toads appear to favour the numerous dry stone walls in the neighbourhood for hibernation.

The question arises as to whether the spawning at this depth is not an accident following the trapping of the toads, but it seems at first a significant fact that spawn was found entwined around the outside of traps which contained no toads, so that this spawning was presumably natural. In 1953, however, a line of traps was specially laid in one of the spawning grounds (Beat 26) at depths ranging from 5 to 30 feet and examined every four or five days. On May 4th, 20 toads were in the 5 foot trap ("a few mating couples but no spawn"), but none in the others. At this relatively shallow depth, many toads were seen sitting on the lake bottom, but no spawn was visible. The next day, 9 toads were in the 5 foot trap and 6 in the 10 foot one. These were all mating, but no spawn was yet visible. On the 8th, the 5 foot trap contained 31 toads and spawn, while the 10 foot one had 4 toads and spawn. On the 12th, the 5 foot trap contained three toads, and another two on the 21st, when the traps were taken out. The traps at 15 to 30 feet never held any toads, although during this period a few toads were collected from the regular perch traps at fifteen feet in Beats 20, 22, 23 and 26. During this experimental trapping, all these traps were set with the entrance facing the shore, and were on the bottom. Traps set at 5 and 10 feet in fifteen feet of water collected no toads. On May 29th, dredging for tadpoles was undertaken in the same area. None were found at 15 or 10 feet, but numbers were taken at 5 feet.

Thus, the final appearance given is one of a toad population spawning in large numbers around a depth of 5 feet, with some spawning as far out as 10 feet. Tadpoles from eggs laid at greater depths than 5 feet seem either to migrate shorewards at a very early age, or else fail to survive long after hatching.

How far the observations of temperature in the depths of the lake may have a bearing on the bottom temperature at the actual spawning sites remains to be seen. It is hoped that findings over future years may elucidate this point. What has not yet been explained is why the toads actually come to the water so late in the year. A few records of frog and toad breeding elsewhere in the neighbourhood (apart from those already recorded—Frazer, 1953) are given in Table 3. Those from previous years have been given by Dr. Macan and the 1953 ones by K. Shepherd. They show that breeding in the lake is definitely later than in other smaller bodies of water in the neighbourhood. Further, in 2 feet of water in Lazy Bay (300 yards North of the trapping site), there were about seventy toads congregated by April 22nd, 1953, including about a dozen in amplexus. By the 30th, these toads had all gone, leaving a quantity of spawn behind them. This was before the first toads of the year had been trapped in deeper water.

During the 1953 work, the temperature was recorded at 5 and 10 feet depths. It was 10.1°C. at 5 feet on May 4th, when the toads were merely sitting about, but had risen to 12° at this depth by the 8th, when spawning had commenced. It was then 11° at 10 feet, where spawning had also

occurred. Four days later, the temperature at 5 feet remained unaltered, but by the 21st had risen to 13° at this depth.

TABLE 3

Records of Frog and Toad Breeding in the Windermere Neighbourhood but outside Lake Windermere

1947	
April 11th.	Ennerdale Lake. Toads spawning in shallow water.
April 15th.	Three Dubs Tarn. Toads spawning.
1948	
February 17th.	Brathay Quarries. Frogspawn.
March 9th	Three Dubs Tarn. Fresh frogspawn. Ustick Moss. Much frogspawn.
April 4th.	Clay Pond. Fresh toadspawn.
April 15th.	Three Dubs Tarn. Many toads in amplexus.
1949	
March 15th.	Ustick Moss. Much frogspawn.
March 28th.	Wise Een peat cutting. Young tadpoles. Wray Mires Tarn. Two pairs of toads.
April 4th.	Wise Een Tarn. Frogspawn Wray Mires Tarn. One pair of toads.
April 14th.	Wise Een Tarn. Frogspawn not yet hatched.
1953	
January 28th.	Flooded cart track near Nor Moss (Wray). Small amount of frogspawn.
February 22nd.	Cart rut in Bishop's Wood (Sawrey). Frogspawn.
April 15th.	Blelham Tarn (Wray). Pair of mating toads.
April 23rd.	Windermere (just North of Ferry House). Two toads dredged from 10 feet.

Although the observations seem to show that breeding in Lake Windermere is later than elsewhere, and carried on at 5 to 10 feet depth, while some may lay in deeper water, the findings so far are inadequate for drawing any great conclusions. It is hoped to continue observations in the future, in the expectation that further findings of interest may occur. I should like now to offer my thanks for help to many members of the staff of the Freshwater Biological Association In particular, Dr. Macan kindly wrote to give me all the information he could on various occasions : he also arranged for me to see the trapping records and to meet other members of the staff. In turn, he had been supplied by Mr. G. Thompson with the original details. To Mr. E. D. Le Cren I am indebted for allowing me facilities to go through all the trappers' notebooks in his charge. Mr. K. Shepherd discussed the whole matter with me, adding details from his own observations over the last few years, and collected all the 1952 and 1953 results for me, being responsible for laying the special line of traps in the

latter year. He also produced the data from which the map is drawn, and made available the data on the lake temperatures. Finally, I should like to thank the Director, Mr. H. Cary Gilson, for giving me the facilities for seeing these various people, and for arranging the 1953 programme of investigation in accordance with my suggestions.

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ATTACKS BY *RANA ESCULENTA* ON *RANA TEMPORARIA* AND *BUFO BUFO* IN CAPTIVITY

By

R. H. AHRENFELDT

Boulenger (1898) states that *Rana esculenta* (in which species, however, he includes *R. ridibunda*) "is very voracious, and large specimens will occasionally capture snakes and small mammals and birds." Malcolm Smith (1951) similarly observes that both *R. esculenta* and *R. ridibunda* are voracious creatures, tending to leap upon their prey and swallow it in a single movement; and that *R. ridibunda* will sometimes "devour fish up to three inches in length, adult newts and young frogs. They are said to take young birds in the nest, and in captivity will eat small mice." It may, therefore, be of interest to record briefly some recent observations of *R. esculenta* attacking *Bufo bufo* and *Rana temporaria* (and eating the latter), in captivity.

Some specimens of *R. esculenta* from Northern France have been kept for some time in a large outdoor tank, which also, until the events described took place, contained *R. temporaria* and *B. bufo* which, it had been thought, would, on account of their adult size (about 40-60 mm. long), be safe from any possible attack from the *R. esculenta*. The latter obtained ample supplies of food throughout.

Late at night, on 28th April, 1953, a toad (about 60 mm. long) was observed floating on the surface of the water, with its body inflated in the characteristic defence reaction, and making feeble movements with its legs. A *R. esculenta* (about 75 mm. long) was seen to be lying on its back under the water, gripping the toad's body with its front feet, and clinging firmly with its teeth to the skin of the toad, between the throat and the belly; and it continued to do so, in spite of the fact that the toad drifted slowly to the other side of the tank, and that, from time to time, in the course of the uneven struggle, the two amphibians turned over on to their sides. More than half an hour elapsed before the toad finally succeeded in freeing itself, and slowly crawled out of the water : no attempt was made by the frog

to pursue it. On close examination, no evidence whatsoever of trauma was was found on the skin of the toad's ventral surface, in spite of the fact that this animal had been almost immobilised and firmly grasped by the frog for this lengthy period.

On 21st July, a large *R. esculenta* (about 80 mm. long) was observed to have half-swallowed, head first, a *R. temporaria* of about two-thirds its own size. During the slow process of swallowing this large meal, the *R. esculenta* was somewhat sluggish, and it was not until some five hours after the prey had first been observed to be already half swallowed, that it was finally completely engulfed by its assailant.

Again, in the early morning of 14th September, a fairly small, adult *R. temporaria* was seen to be attacked in the water by a *R. esculenta;* the latter was beneath the surface of the water, and was dragging down the apparently helpless *R. temporaria.* One hour later, the *R. temporaria* had succeeded in freeing itself but when, later in the day, it was proposed to remove the *R. temporaria* from its dangerous environment, it could not be found, and it must be concluded that it, too, had eventually been devoured by a *R. esculenta.*

Malcolm Smith (1951) has recorded that *R. temporaria* and *B. bufo,* once abundant in the Romney Marshes, are now apparently disappearing, since the introduction and spread of *R. ridibunda* in that area. In the light of these observed attacks by *R. esculenta,* whose habits are very similar to those of the closely related *R. ridibunda,* on *B. bufo* and *R. temporaria* (in captivity), it would seem highly probable that, in the Romney Marshes, both the common indigenous species of Salientia have been attacked, and are being exterminated, by *R. ridibunda* (which also eats tadpoles and small frogs and toads). As Malcolm Smith observes, the effect which the Marsh Frog will have upon our native fauna cannot yet be determined; but it is possible that this species will, indeed, ultimately have an effect (at least locally) on our fauna, similar to that of the introduced Grey Squirrel (*Sciurus carolinensis*) upon the native Red Squirrel (*S. vulgaris*).

It is interesting to note that "*R. esculenta,* with its long history of residence in this country, has not appreciably affected the native fauna in the same way" as *R. ridibunda* (M. Smith, 1951), but this may well be consequent upon ecological factors, in so far as *R. esculenta* never seems to have established itself so thoroughly, so rapidly, or over so wide an area, as has *R. ridibunda* in the Romney Marshes. In fact, the distribution of *R. esculenta* in England appears to have receded appreciably in the course of time.

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FROG AND TOAD BREEDING RECORDS FOR 1953

Compiled from the phenological reports sent in to the British Herpetological Society

By

J. F. D. FRAZER

The weather summary for the months concerned with spawning has been taken from the Monthly Weather Reports of the Meteorological Office published by H.M. Stationery Office.

January, 1953. The weather of this month was dry, and was milder than usual in the southern half of England and Wales. A severe North-westerly gale prevailed on the 31st, with severe floods and damage on the East Coast from Yorkshire to the Thames estuary.

Temperature: The first eight days were cold with severe frosts. The remainder of the month was mild in the North, but in the South was predominately cold until the 26th. From the 27th to the 30th, mild conditions prevailed throughout the country.

Precipitation: In England and Wales it was the driest January since 1896. Snow or sleet occurred at many places in S.E. and E. England during the first eight days, and again on the 24th and 31st.

Summary for the month: Dry.

February, 1953. The month was dry in most areas. Generally cold with hard frosts locally during the first fortnight, and in England it remained cold until the 17th. Much snow between 8th and 14th. From 18th onwards, very mild for the time of year. Snow or sleet occurred frequently during the first fourteen days.

Summary: Mainly dry. Cold at first, becoming mild after the 17th.

March, 1953. The month was notable for exceptionally high mean pressure. Except in the North of Scotland it was quiet, with frequent fog. Little or no rain fell in most areas until the 26th, but heavy rain occurred in Wales, N.W. England and locally in the Midlands on the 28th and 29th. Over the whole of the British Isles it was the driest March that has been recorded for many years. Extreme temperatures for the month: England and Wales, 71°F. at Durham on the 24th, and many places in England on the 25th; 14°F. at Moor House on the 16th.

Summary: Mainly dry. Cold at first, becoming very mild after the 17th.

April, 1953. The weather was unsettled, apart from a fine spell from the 18th to the 25th. It was wet in most districts, but drier than usual in S.W. and Central Scotland. Sunshine exceeded the average almost everywhere, particularly in the West and North. Mean temperature was below the average. The only warm days occurred from the 21st to 24th, and even these days were cool on the East coast of England. Ground frosts were numerous. Extreme temperatures, England and Wales: 72°F. at Ringwood on the 22nd, 16°F. at Moor House on the 10th.

Summary: Sunny; wet on the whole; rather cool.

It is seen from this that the first three months of the year were exceptionally dry. Mild weather started about the middle of February, but it had become cold again about the beginning of April. Despite the early cold

TABLE 1

Main Data from Frog Breeding Records

Locality	*Observer*	*Breeding site*	*Depth*	*Spawn dates*
SCILLY ISLES				
St. Martin's	Mrs. Shirley	Pond A	10 in.	3–23
		Pond B	6 in.	26–58
		Pond C	8–10 in.	28–62
SOMERSET				
Taunton	K. R. C. Neal	Lake		55–59
Clevedon	C. E. Dyte	Pond	3 in.	84
LANCASHIRE				
Preston	J. Brindle	Pond	1–1½ in.	49–69
Hawkshead (200 ft.)	J. D. Allonby	Pond A	18 in.	55
Hawkshead (200 ft.)	J. D. Allonby	Pond B	12 in.	55
Hawkshead (350 ft.)	S. Nield	Pond	12 in.	59
E. Hawkshead (700 ft.)	S. Nield	Cart-rut	4 in.	59
Bowness (250 ft.)	S. Nield	Pond	18 in.	65
HAMPSHIRE				
Alton (450 ft.)	R. H. Ahrenfeldt	Outdoor tank	6 in.	93
SURREY				
Addlestone	H. M. Lowden	Puddle	Few in.	53
		Stream A	Few in.	73
		Stream B	Few in.	74
		Stream C	Few in.	79
		Pond P	3–6 in.	70
		Pond Q	3–6 in.	73
		Pond R	3–6 in.	74
		Pond S	3–6 in.	75
		Pond T	3–6 in.	79
Woking	M. Smith	Pond, Site A	6 in.	58–60
		Pond, Site B	6 in.	61–62
Horsell	M. Smith	Pond	6–12 in.	68–69
Dorking	J. F. D. Frazer	Large pond	6 in.	74–79
SUSSEX				
Hastings	B. Hutchinson	Stream	4 in.	83
		Pond	2–18 in.	91
Hove	E. M. Atkins	Pond		Never
MIDDLESEX				
Hendon	C. A. Rose	Pond		Never
Finchley	R. Bushnell	Ditches	5 in.	86–87
ESSEX				
Eastwood (450 ft.)	B. James	Pond	5 ft. 6in.	84
STAFFORDSHIRE				
Streetly	Mrs. Bate	Concrete pond	6 in.	80
HUNTINGDON-SHIRE				
Kimbolton	O. N. Bishop, *et al.*	Pond	12 in.	85–89

Locality	*Observer*	*Breeding site*	*Depth*	*Spawn dates*
YORKSHIRE				
Glusburn (450 ft.)	A. Butterfield	Pond A	4 in.	(65–67 (84
		Pond B	30 in.	83–85
Otley	S. Heron	Pond	3–9 in.	56–64
LINCOLNSHIRE				
Grimsby	R. Lawson	Stream	2–in.	—
ARGYLLSHIRE				
Benderloch	Miss Davidson	Bogs	2–4 in.	49–52
ABERDEENSHIRE				
Braemar (1,100 ft.)	J. M. Cumming	Pond	6 in.	56–59
INVERNESS-SHIRE				
Newtownmore (1,200 ft.)	G. W. Harper	Boggy tracks	Under 1 in.	Before 114

TABLE 2

Main Data from Toad Breeding Records

Locality	*Observer*	*Breeding site*	*Depth*	*Spawn dates*
CORNWALL				
Falmouth	M. D. Grogono	Concrete pond	6 in.–2 ft.	53–54
DEVONSHIRE				
Exmouth	A. M. Leadley-Brown	Concrete pond	22 in.	56–71
Sidbury	P. W. Hopkins	Lake	5 in.	56–84
		Disused swimming pool	4 in.	70–84
SOMERSET				
Taunton	K. R. C. Neal	Lake		55–58
SURREY				
Cheam	R. C. Hinton	Pond	9 in.	137
Dorking	J. F. D. Frazer	Large pond	6 in.	79–85
SUSSEX				
Hastings	B. Hutchinson	Pond	2–18 in.	77–79
ESSEX				
Thorpe Bay	B. James	Pond A	2–3 ft.	91–98
		Pond B		98–102
HUNTINGDON-SHIRE				
Kimbolton	O. N. Bishop	Pond	12 in.	76–77
YORKSHIRE				
Kirkburton (300 ft.)	E. Lees	Reservoir	2 ft.	79–100

weather, the first frogs were breeding in the Scilly Isles in January (see Table 1). However in the two later of the three ponds, spawn was not plentiful until the latter end of February. It should be remembered though that not only is there a milder winter there, but that St. Martin's is the most sheltered island, as evidenced by the fact that their flowers normally reach Covent Garden a few days before those from the other islands. Pond A is on the sheltered South side of the island: most of the spawn there had hatched by January 30th. The average air temperature from the 10th to the 17th was 46° to 47°, and by the 27th even the water temperature was 50°F. Pond B is on the North side of the island (in boggy ground), but was at 50° on January 27th, and had reached 60° by March 2nd. Pond C is on the South side again, but in a shaded situation under a wall. The temperature was only 48° by January 28th, and 59° by March 3rd. Thus, the order of spawning was from warmest to coolest.

The order of spawning in different parts of the country remained much the same as last year, although (apart from the Scottish and Preston localities) apparently a week or two later in 1953 than in 1952. Unfortunately there were not a large number of records from the same localities in both years: at Taunton, the data given in Figure 2 shows that spawning was actually earlier this year.

The figures for Benderloch, Argyll, show a similar correlation with temperature to those for the previous six years shown in last year's report. The plot in Figure 1 gives corroborative data for Preston, where the start of spawning occurred in the middle of a sharp rise in air, water and grass temperatures. Variation in the relative humidity seems unimportant, as does that in barometric pressure. It is noticeable also that spawn only became plentiful after a second similar temperature rise had followed a cold spell. At Streetly, Staffordshire, frogs were in the water by March 7th, although there had been ice on it for each of the preceding three mornings. The surface was covered with ice on the 16th, and yet spawn was plentiful by the 21st (Mrs. Bate).

Similar associations with temperature are shown in Figure 2, where again spawning occurred in both years after a sharp rise in temperature, so that in the water it registered 48°F. or more. Figure 3 gives similar data for frogs and toads at Kimbolton, Huntingdonshire (O. N. Bishop *et al.*). These figures again stress the correlation between air and water temperatures which was shown in last year's report. Although rainfall was not then considered a significant factor, it should be pointed out that data from Hastings (B. Hutchinson) show that rain there was accompanied by a sharp drop in temperature, both at ground level and in the water at the spawn site.

Figure 2 also compares toad spawning with the frogs in the same locality, and it is interesting to note that the main spawn period of the toads coincided with the start of the main spawning of the frogs.

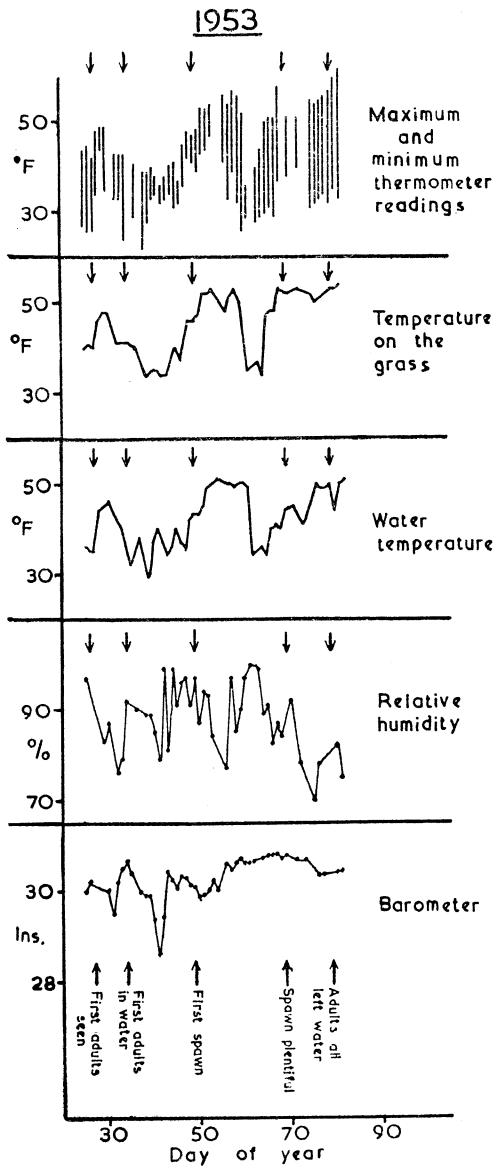

Fig. 1. Observations on temperature, barometric pressure and relative humidity in 1953, at Preston, Lancs. (J. Brindle).

At Glusburn, Yorkshire (A. Butterfield) frogs are shown to have spawned after a fall in temperature. Here, a second assembly spawned 19 days later, on March 25th, at the same time as the only spawning occurred in a neighbouring pond. At Addlestone, Surrey, a series of records was provided (H. M. Lowden) from an area of under one square mile, so that weather conditions must have been fairly constant. (See Table 1.) The puddle and Stream B were a mere 100 yards apart, so that it must be assumed that the differences in spawning dates must be conditioned by local factors, of which the likeliest are temperature differences in the spawning areas.

It may be seen from a comparison of Table 2 with Table 1 that the toads in general spawned later than the frogs in any one locality, but in Huntingdonshire the toads were actually the earlier. Some interesting data for Exmouth (supplied by Mrs. Leadley-Brown) are shown in Figure 4, relating to a concrete pond in which the toads could be easily detected. The daily number of toads in this pond are shown, from which it is seen that a slight rise in the number of males present occurred just before spawn became plentiful. The numbers had previously fallen away rapidly after the first spawn had appeared. (It is known that these numbers were definitely as shown by sexes, as on this first day every toad in the pond was handled and then released again.) Thus there was here a second migration of both sexes to the pond.

In parenthesis, the question of visibility of the toads in the pond is an important one, as is shown by events at Dorking, Surrey (J. F. D. Frazer). There, on March 20th, it was found that no toads were apparently in the breeding pond, as viewed from the bank. This was on rather a cold morning. But when one waded into the pond, it became apparent that there were single male toads and a few pairs sunk in holes in the mud of the bottom : a small amount of spawn was also seen. As the morning became warmer about 11.30, the toads tended to come more to the surface, and even to croak. A few days later, on the 25th, there were large numbers of toads present with much spawn. It was also noticeable on this latter date that a pond about 100 yards away contained numerous toads but no spawn. This latter pond was shaded and definitely much colder than the other. Thus, it is apparent that temperature again had its effect on the spawn date of the toads in this locality.

One record has been received of frogspawn and tadpoles in Guernsey. This was seen on March 21st (R. Brehaut), when it was estimated that hatching had only occurred during the preceding week. Unfortunately, it is not known which of the Guernsey species (*Rana temporaria* and *R. agilis*) was responsible.

Apart from records of actual spawning, other interesting facts have been elicited. In general, there was a delay between the arrival of the first adults at the ponds and the start of spawning, although amongst the frogs this did not hold for a pond at Woking (M. Smith), while in the Scilly Isles the

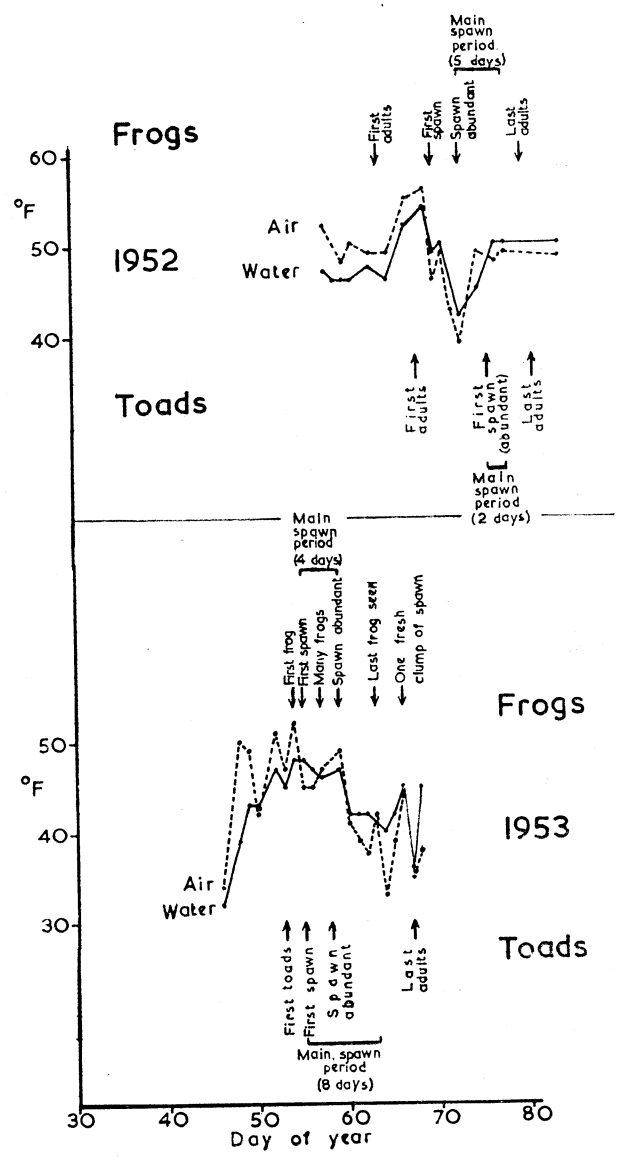

Fig. 2. Records of frog and toad breeding in 1952 and 1953, correlated with temperature, Broomfield Lake, Taunton (K. R. C. Neal).

start of breeding was almost immediate (Mrs. Shirley). In this latter locality, though, frog spawning was rather protracted. In most localities, the adults did not leave until a week to ten days after the main spawning, but at Woking and Horsell (M. Smith) and at Otley, Yorkshire (S. Heron) there was only an interval of a day or so before their departure. At Finchley, Middlesex (R. Bushnell) the males remain in the breeding ditches all the summer, although the females leave within a week of spawning. At Clevedon, Somerset (C. E. Dyte), frogs were still present on May 14th, spawn having been abundant seven weeks earlier.

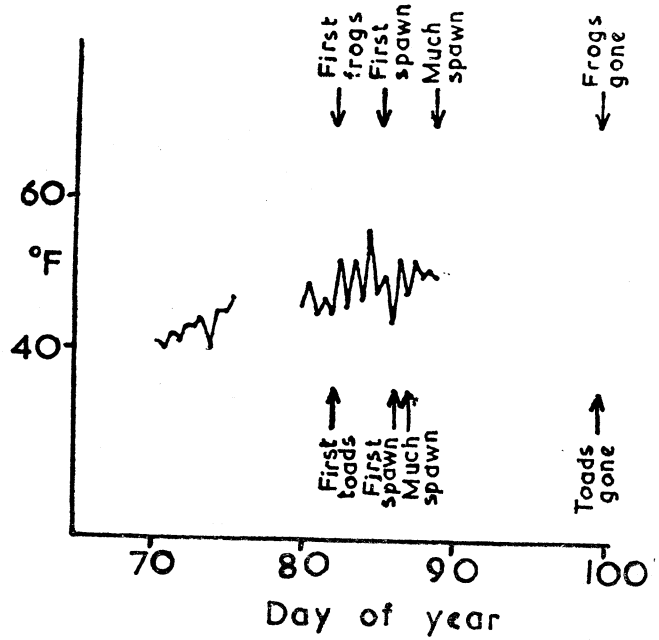

Fig. 3. Records of frog and toad breeding in 1953, given against water temperature (morning and evening records). Kimbolton, Huntingdonshire (O. N. Bishop, P. H. Giles and A. Hall).

There seem also to have been local disturbances of the breeding rhythm. Thus, at Hove (E. M. Atkins) croaking and pairing were noted but no spawn. Of course, this may not have been a breeding pond; but at Hendon (C. A. Rose) only two single frogs and no spawn were seen in the pond where they bred last year. At Preston (J. Brindle) where four ponds were used in 1952, only one of these remained in use this year, neither spawn nor tadpoles being found in the others. Toads here were also conspicuous by their absence from the pond where they bred last year. In Essex, B.

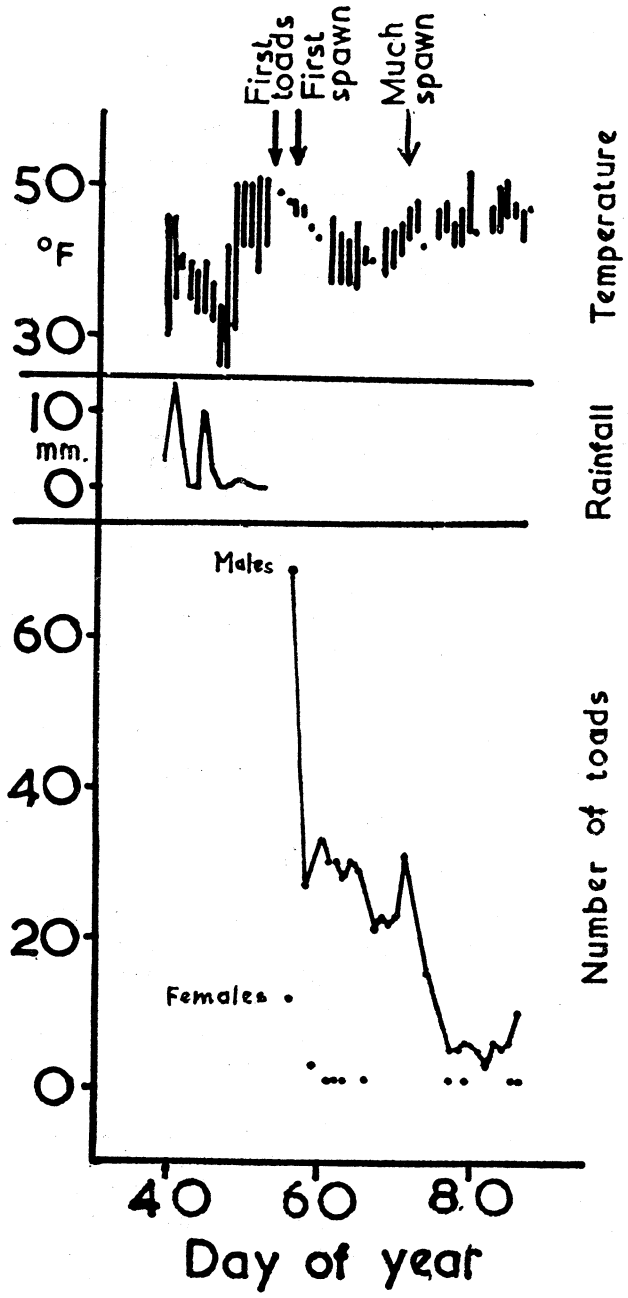

Fig. 4. Details of toad spawning, temperature, rainfall and number of toads in water. Exmouth, Devon (A. M. Leadley-Brown). N.B.—The temperature details consist of maximum and minimum thermometer readings until the first appearance of toads; while, after this, water temperatures at 8.30 a.m. and 4.30 p.m. are recorded.

Jabes reported "Many dead toads and newts were found in water, killed by salinity met on journey to water. . . . In same locality as 1952, but a distinct stream was used owing to inundations caused by flooding of the Thames".

Toads started to reach their breeding sites a few days before pairing started, and remained from a week to six weeks (Falmouth, M. D. Grogono) after most of the spawn was laid. Testimony to the very cold weather over this period is given by the fact that the first tadpoles did not appear until April 10th, four days after the last pair of adults was seen. At Cheam, Surrey (R. C. Hinton) the adults did not appear until May 4th. In the next fortnight the weather was hot (around 60°F.), but they did not spawn until the 17th, after half an inch of rain had fallen in three days.

To sum up, the warmer weather early in the year seems to have attracted frogs and toads to the breeding sites, in some cases rather earlier than usual. The cold weather in March, however, seems to have caused some of them to remain there for longish periods (up to maxima of 47 days for toads and nearly three months for frogs). Spawning only occurred with the arrival of warmer weather. But in Surrey one locality showed toads delaying breeding during a spell of warm weather, until after some rain had fallen.

Once again, I should like to thank all those who sent in records or supplied other information on which portions of this paper have been based.

THE FEEDING HABITS OF THE MARSH FROG (*RANA RIDIBUNDA RIDIBUNDA*)

By

MALCOLM SMITH

The stomachs of the frogs first examined by me for their food contents suggested that the main diet of these animals was obtained in the water (Smith, p. 154). An examination of a larger series, however, shows that they feed quite as much on land, finding their food on the banks of the canal from which they are never far distant. In their choice of food they are extremely catholic; there are indeed very few creatures that they will not devour.

I am indebted to members of the staff of the British Museum (Natural History) for identifying the material eaten; Mr. Balfour Brown the insects, Dr. H. E. Quick and Mr. G. L. Wilkins the molluscs, Mr. W. H. Tams the moth caterpillars and Mr. E. Browning the spiders. Mr. M. H. Hey has kindly examined two samples of water and reports as follows as regards their salinity: Grand Military Canal: 267 parts per million of Chlorine corresponding to 441 parts per million of Sodium Chloride. Canal at

Shargate: 202.5 parts per million of Cl per litre corresponding to 334 parts per million of NaCl.

The following are detailed lists of the stomach contents of the frogs. Species marked with an * are aquatic, those marked with ** are both aquatic and terrestrial.

Six adult frogs caught 26.5.1952.

COLEOPTERA. *Hyphydrus ovatus** (Dytiscidæ). *Cardiophorus equiseti* (Elateridæ). *Prasocuris phellandrii** (Chrysomelidæ). *Elaphus cupreus* ? *Bombidion,* elytra only (Carabidæ). *Microcara testacea* (Helodidæ). *Elater* sp. (Elateridæ). *Stenus* sp. (Staphylindæ). *Galerucella sagittariæ** (Chrysomelidæ).

MOLLUSCA. *Succinca pfeifferi.*

ARACHNIDA. *Pirata* sp.

CRUSTACEA. Woodlice, spp. not identified.

Ten adults caught 20 to 26.9.1953.

PISCES. Three 3-spined Sticklebacks (*Gasterosteus aculeatus*) eaten by one individual, the largest specimen 38 mm. in length.

MOLLUSCA. *Helix* (*Cepæa*) *hortensis.*

VERMES. Several earthworms too digested to identify.

INSECTA. COLEOPTERA: *Feronia nigrita* (Carabidæ). *Elaphrus cupræus* (Carabidæ). *Sermylassa halensis** (Chrysomelidæ). HEMIPTERA: *Naucoris* *. LEPIDOPTERA. *Apanea unanimis*, many adult larvæ.

ARACHNIDA. *Araneous sclopstarius. Pachygnatha clercki. Clubiona phragmitis. Lycosa* spp.

CRUSTACEA. Woodlice, spp. not identified.

In addition to the adults the stomach contents of eight young frogs recently metamorphosed were examined. They were caught in different canals betweent September 20th and 26th, 1953. The date on which the spawn was laid from which these frogs came is not known, but spawn was found on May 17th and reckoned to be then about a week old.

The tadpoles of *Rana ridibunda* are never seen swimming freely in the water as are those of *R. temporaria* and *R. esculenta.* They can be obtained only by netting the aquatic vegetation in which they hide. This habit no doubt is necessary for their survival for the canals are well populated with fish and a free-swimming larva would be quickly caught and devoured. As they do not live in dense colonies the question of starvation and stunting of growth from lack of food would not appear to arise. Some other factor, not yet known, must be the cause of the great variability in the rate of their development. Metamorphosis may be completed in three and a half months but with most tadpoles it is longer and in some is not accomplished when

winter sets in and development ceases. The tadpoles continue to grow until metamorphosis takes place and in consequence those that transform in late September are distinctly larger than those in which it has taken place in August. This increase in growth is naturally reflected in the size of the young frog, those that metamorphose late in the year being as large as those that have transformed a month or six weeks earlier. Forty young frogs caught in the fourth week in September, 1953, varied in length from 29 to 33 mm. from snout to vent.

Spec. 1. Length snout to vent 30 mm. Tail not fully absorbed, 4 mm. remaining. The animal had left the water and was feeding on land. Aphides (Green Fly), some 30 individuals. Parasitic hymenoptera, two individuals.

Spec. 2-8. The tail in all was completely absorbed.

INSECTA. COLEOPTERA: *Sitona hispidus, Apion* spp., *Bagous* spp. (Curculionidæ), *Phædon armoraciæ, Prasocuris phellandrii***, *Chrysomelid larvæ* (Chrysomelidæ). *Enochrus* 4-*punctatus** (Hydrophilidæ), *Longitarsus* ? *tabidus* (Halticidæ), *Acupalpus* sp. elytron only (Carabidæ). DIPTERA: *Tipulidæ* and larvæ, *Ephydridæ,* small nematocarus larvæ. HYMENOPTERA: *Formicidæ* fragments, *Ichneumonidæ* fragments. HEMIPTERA. NEUROPTERA. *Sigara* spp.*, Aphides. *Hemerobiid* larvæ.

ARACHNIDA. Fragments of cepalothorax.

APTERYGOTA. Collembola.

BOOK REVIEW

DANGEROUS SNAKES OF AUSTRALIA. ERIC WORRELL. Angus and Robertson, Sydney and London.

A small pocket-sized book describing twenty-three Australian snakes dangerous to man. Each species is simply but accurately described and a number of good photographs show most of the snakes in a threatening attitude.

One chapter covers the latest treatment for snake-bite and another describes the action of venom of the various species.

An accurately, sensibly written book which, although written primarily for the Australian field-worker, will be a welcome addition to the library of anyone interested in herpetology. It is obvious that the author has some considerable knowledge of snakes and it is hoped that he will follow up this book with an enlarged edition.

J. W. L.

NOTES

HERBIVOROUS SNAKES

On more than one occasion I have found that certain apparently incredible African beliefs with regard to certain plants and animals proved on closer study to be true. Years ago, on the Gold Coast, I was told that a yellow, fleshy fruit, *Momordica fœtida,* filled with soft reddish pulp, in which the quite large seeds were embedded, was beloved of snakes. Later I discovered that its local name meant "snake's food"; and years later I discovered some seeds in a snake's stomach which resembled closely, if they were not identical with, those of *Momordica fœtida.*

Dr. J. M. Dalziel in his "Useful Plants of West Tropical Africa," 1937 (p. 458), describes how snakes are said to frequent trees of *Vitex micrantha* (Verbenaceæ) to eat the fruit.

Other possible evidence on the subject is a local belief that both snakes and birds have a fondness for the fruits of *Capparis tomentosa* and *Capparis corymbosa.*

These three facts make me wonder whether snakes, with their carnivorous habits, and teeth not particularly suitable for a vegetable diet, could in fact sometimes eat certain soft and pulpy fruits. I have been unable to find any reference other than that of Dalziel, or any first-hand evidence other than my own. I am, therefore, writing to ask whether any of your readers can send me any references or information on this subject. I should be most grateful if they could do so.

F. R. IRVINE.

30*th October,* 1953.

32 Tavistock Square,
London, W.C.1.

COMMON FROG SWALLOWED AND REJECTED ALIVE BY GRASS SNAKE

On 23rd July, 1953, a female grass snake was caught on the Quantock Hills. Its length, head to tail, was 890 mm. It was housed in an open, outdoor vivarium, 4 square feet in area.

Normal diet consisted of as many frogs as could be obtained, and would be eaten. On 14th August a fairly large female frog was eaten, at about 10.30 a.m. At midday I had occasion to handle the snake, which immediately rejected the frog, which was found to be alive. It lived until the evening of the same day, when it was re-eaten.

From this it would appear that, even at a fairly high temperature (70°F.), food travels down the internal organs of a Grass Snake at an extremely slow rate, and digestion cannot commence for at least two hours after a meal has been eaten.

ROGER AVERY, "Lotherton," Galmington, Taunton.

VIPERINE SNAKE (*NATRIX MAURA*) IN KENT

On 5th July, 1953, two snakes were observed basking together in the sun at Joyden's Wood, near North Cray, Sidcup, Kent. One was captured but the other, which was not identified, escaped.

The captured specimen could not be identified as any of the British species, so it was taken to the Zoological Society of London, where it was identified as a Viperine Snake, *Natrix maura*, which occurs naturally in south Europe and north-west Africa.

It is assumed that the snake either escaped from some vivarium, or had been imported accidentally in some freight. A notice published in the *Sidcup and Kentish Times* and careful enquiries made in the neighbourhood, failed to produce any information on the possible source of the snake.

DAVID M. EDWARDS, 17, Sandhurst Road, Sidcup, Kent.

OBITUARY

L. A. LANTZ

Louis Amédée Lantz died in Switzerland on February 3rd, 1953, at the age of 66. Born and educated in Alsace he was a chemist by profession but throughout his life he was keenly interested in herpetology. His first appointment, after graduation and apprenticeship, was in Moscow, where he lived for ten years. During this period most of his vacations were spent in the neighbourhood of the Caucasus collecting and observing the herpetofauna. His conclusions were embodied in a series of papers, some systematic and faunistic, others concerned with observations made in the field or on specimens kept in captivity. The first-mentioned group of papers forms the backbone of our knowledge of the lizards of the region, and the most important of the series is "Les Eremias de l'Asie Occidentale," published in 1928. His interest in living specimens in captivity, particularly amphibians, was also of great importance. Continuing the work of Wolsterstorff and others, with whom he collaborated, he conducted a large number of experiments on the hybridisation of amphibians with the object of establishing the status of suspected hybrids, the occurrence of natural hybrid populations, and the relationships between the various forms.

Leaving Russia as a result of the revolution of 1918 he became Director of the Research Laboratory of the Calico Printers' Association in Manchester and this post he held until his retirement in 1950. His herpetological work continued in the pattern of previous years except that now his summer vacations were spent in the Pyrenees or on the Mediterranean littoral. The herpetofauna of this region offered less taxonomic scope and, in fact, no major revisions such as had characterised his work in the Caucasion region, were completed. Nevertheless his acute powers of observation and analysis brought to light several previously unrecognised races.

His best work, however, resulted from his field observations (one may recall his surprising discovery that in the high Pyrenees the viviparous Lizard is oviparous) and his experimental breeding, where his chemical training and experience made him an outstanding technologist. In this field he had many objects, some comparatively simple (for example, to record growth and age changes) others more ambitious, but mostly concerned with the occurrence of sterility barriers in relation to the distribution of species, sub-species and natural hybrid populations. In 1947 (*Proc. Zool. Soc. London, 117,* pp. 247-258) he was able to round off the work of Wolsterstorff and others and present a review of all the European Newts (*Triturus*) in this aspect of their relations and discovered the factor that limits the occurrence of the hybrid "species" *Triturus blaasi;* although the females of this hybrid (Crested and Marbled Newt) are fertile and reproduce with either of the parent species all the male hybrids are sterile. Cytological study of his hybrids revealed (White, 1946, *Journ. Exp. Zool.,* 102) that this sterility arises from the inability of the chromosomes to pair normally for spermatogenesis. It was probably this discovery that impressed him with the need for genetical analysis of the results of his breeding experiments and cytogenetic investigation of the hybrid material. During the last few years of his life he began collaborating with workers in these fields and at the time of his death several important investigations were under way. Some of these were virtually complete and the results have been, or will be, published; but it is a matter for the deepest regret that his plans for the continuation of this kind of work in the greater leisure of his retirement were cut short.

Lantz will be remembered by those who knew him for his invariable courtesy and kindliness, his quiet, simple, direct nature and his deep love of herpetology. Those who only know his published works may divine some of these characteristics, but will certainly be aware of his acuteness of observation, meticulous accuracy, orderly mind and complete grasp of any subject on which he wrote.

H. W. PARKER.

10th August, 1953.

Louis Lantz who died recently in an unhappily short time after his retirement, was French by birth but spent some years in Russia early in the century and worked in Manchester, until he retired in 1951, as a research chemist concerned with dyestuffs.

He was naturally cosmopolitan in outlook and his herpetological interest embraced the reptiles and amphibians of all Europe. He had conducted inter-breeding experiments with most of the races of *Triturus cristatus* and he knew most of his subjects in their breeding haunts. His enquiring mind and his professional preoccupation with colour combined to stimulate experiments over many years designed to discover whether pattern and hue could be influenced in captivity by breeding successive generations of newts in a

series of varying environments. His stock was always well cared for and long-lived and it was characteristic of him that at height of meat rationing, some of his meagre allowance was devoted to his reptiles.

Modest and dignified in bearing, ever courteous and humane, deriving from a more civilised tradition than is at large to-day, the world is the poorer for his passing and our sympathy is extended to Mrs. Lantz and to his daughter.

ELLEN HAZELWOOD.

LIST OF MEMBERS OF THE BRITISH HERPETOLOGICAL SOCIETY

ADDITIONS AND CORRECTIONS

CORRIGENDA

ALLEN, S. E., *now at* Guards Villa, Abbey Town, Cumberland.
BADGER, Mrs. S. E., *for* Olney Avenue *read* Whittle Avenue.
BELLAIRS, Dr. A., *now at* St. Mary's Hospital Medical School, Paddington, W.2.
GODDARD, Plt. Off., *now at* Officers' Mess, R.A.F., Waterbeach, nr. Cambridge.
GOOCH, Bernard, *now at* 6 Harbour Court, Canford Cliffs, Dorset.
HELLYAR, A. R., *now at* 9 St. Lawrence Avenue, Hakin, Milford Haven, Pembrokeshire.
HOOFIEN, Jacob, *now* c/o Bank Leumi le Israel, B.M., Tel Aviv Branch, P.O.B. 2, Tel Aviv, Israel.
JOHNSON, Harold, *now at* 321 Ashton Old Road, Openshaw, Manchester, 11.
RANKIN, A., *now at* 90 Penketh Road, Upper Brighton, Wallasey, Wirral, Cheshire.
WOOD, A. C., *now at* Longcroft, Station Road, New Waltham, nr. Grimsby, Lincs.

ADDENDA

AMPS, Bernard M., 14 St. Edmundsbury Road, Kings Lynn, Norfolk.
BENNETT, F. R., 116 Fillebrook Road, Leytonstone, E.11.
BLOMFIELD, Peter, D.S.O., D.F.C., 72a Leigham Court Drive, Leigh-on-Sea, Essex.
BRAME, Arden H., Jnr., 340 South Clark Drive, Beverley Hills, California, U.S.A.
COOK, Lawrence M., 6 Westbourne Gardens, Glasgow, W.2.
COPPING, Robert, 57 Belsize Park, N.W.3.
ELLSWORTH, Ronald F., 31 Hariet Street, Brighton 35, Mass., U.S.A.
FRITCHE, G. E., L.D.S., Pinnocks, Verwood, Dorset.
HEWITT, Walter A., Northcroft Lodge, Englefield Green, nr. Egham, Surrey.
HUGHES, R., 16 Elm Street, London Road, Peterborough.
JOHNSON, K. W., The Lodge, Ratho, Midlothian.
LANSDOWNE, D. K., 3 Farmleigh, Southgate, N.14.
LANTZ, John Perry, Box 793, University of Miami, Miami 46, Florida, U.S.A.
LUCAS, Kenneth St. J., 11 Sion Hill Avenue, Casimir Road, Rathmines, Dublin, Eire.
MOUNTFORD, D. W., 89 Hanley Road, Sneyd Green, Stoke-on-Trent.
PARRY, Ellis E., 25 Broad Mead, Luton, Beds.
PHEBY, P. J., 36 Ringmer Road, North Moulscombe, Brighton 6, Sussex.
PICKARD-SMITH, Mrs. K., Harveys, Glynde, Sussex.
ROBSON, C. B., c/o U.A.C. Ltd., Eket, Eastern Nigeria, West Africa.
ROSE, Dr. Walter, Oaknook, Protea Road, Newlands, Cape Province, South Africa.
SALMON, Frederick, Airport Hostel for Animals, London Airport, Middlesex.
SANDERSON, Leonard, 82 Ackroyd Street, Morley, nr. Leeds.
SAYER, Peter Donovan, 7 Bramley Way, West Wickham, Kent.
SMITH, Maurice E., Attlebridge, nr. Norwich, Norfolk.
SMITH, Robert K., 15 Ross Parade, Wallington, Surrey.
TAYLOR, Dr. Edward H., Museum of Natural History, University of Kansas, Lawrence, Kansas, U.S.A.
TAYLOR, Peter, 15 Lines Road, Droylesden, nr. Manchester.
WOOLFORD, Mrs. D., 63 Agincourt Road, N.W.3.
WRIGHT, F. C., 38 Elm Street, London Road, Peterborough.