REVIEW

The Zoological Record for the Sections on the Amphibia and Reptiles for the year 1953 has now appeared. Copies have been presented to our Society by the Zoological Society of London and are now in our library. These publications are a complete record—as far as it is possible to make them—of all the articles, papers and books on herpetology in all the languages of the world which have appeared during that year, together with others which have been inadvertently omitted in previous years. The contents of each Section is divided into three sub-titles. The authors are listed alphabetically, and in the Subject Index their contents are analysed according to the matter contained. Finally, there is a Systematic Index listing the species dealt with and arranged according to their classification. No herpetologist who wishes to be conversant with the literature on his subject can afford to be without these works. The Amphibia is compiled by Alice Grandison for the recent species whilst the fossil are dealt with by Dr. W. E. Swinton. The Reptilia is by Mr. J. C. Battersby and Dr. Swinton. The price of the Sections is 3s. 6d. and 4s. respectively.

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Contributors will be supplied with 10 reprints of their articles free of charge; additional copies may be ordered at cost price. The number required must be stated when the manuscript is submitted.

THE BREEDING HABITS OF FROGS AND TOADS, BROOMFIELD LAKE, NEAR TAUNTON, 1952-4

By

K. R. C. Neal

The breeding habits of frogs and toads are governed by certain factors, but it is not at all certain what these factors are. Weather undoubtedly plays an important part in determining when the frogs and toads return to their breeding sites, and these observations were made to find out, if possible, the exact weather conditions both before and during breeding.

In 1952 and 1953 only two sets of readings were taken. 1. The temperature of the water; 2. The temperature of the air. The former was taken at the same place each day and efforts were made to take it at approximately the same time (4-5 p.m.) so as to get all the readings relative. Temperatures taken at a different time each day would make a graph meaningless. For instance, on March 1st, 1953, the water temperature was 36 deg. F. at 8.45 a.m., but at 4 p.m. was 42 deg.

The air temperature was taken at ground level. This was always taken before the water reading because after the thermometer had been in the water it tended to register a degree or so lower than before because of evaporation on its surface. The same thermometer was used for all three years.

Unfortunately the general weather was not noted in 1952, but this was remedied in 1953.

In both years the following points were noted :—

(a) Date of arrival of frogs and toads. (*Rana temporaria* and *Bufo bufo*.)
(b) Date of first spawn.
(c) First date when spawn was plentiful.
(d) Date when frogs and toads had all left the water.

From these dates the following could be calculated :—

(a) Total time in water.
(b) The main period of spawning.
(c) The number of days the frogs and toads were in the water before spawning.

In 1954 far more detailed weather readings were taken. A maximum-minimum thermometer was put behind a tree-trunk (facing N.) four feet from the ground. It remained there throughout the period of observation. The shade temperature, of course, was taken, but unfortunately as the days became longer some early morning sun did get on to the thermometer and once or twice interfered with the maximum reading.

A rainfall gauge was set up and the rainfall was measured daily at

approximately the same time (4-5 p.m.). The water temperature was taken at a different place from 1952 and 1953. It was deeper water and thus the temperature tended to be more constant. Moreover, this was the place where the majority of the 1953 toads had come to breed and it was considered that the water temperature should be taken at the most populated breeding site.

A note was also made of the weather generally, e.g., cloudy, bright periods and showers. Rather cool. Mod.-strong W.-S.W. wind. Clear and cold in the night.

Counts were made of the number of toads. Unfortunately I did not begin this until a few days after they had arrived, so for the first few days I had to give a very rough approximation of the numbers. The same technique was used each time. I went practically right round the lake noting each toad I saw on the edges, and putting down in my notebook a 1 or a 2, denoting whether it was a single male or a pair (I saw no single females). Obviously I did not count anything like the whole number, but I think on the whole I have obtained a fairly relative estimate. I only counted the toads because the frogs were far too elusive to get accurate counts and also because they were few in number. From these counts I could correlate the number of single males and the number of pairs, and by putting in the water temperature as well, quite interesting results were obtained. (See graphs.)

Before giving a comparison of the dates, etc., for all three years, a brief description of the lakes would, I think, be useful. Broomfield lake is situated at an altitude of about 675ft. It is a thin stretch of water shaped roughly into an arc, the main stretch being less than 100yds. in length, the width varying from between 20 and 30yds. It is shallow, not more than 2 or 3 feet at the deepest part. Most of the bottom is mud, but in places there is a considerable amount of leaf litter. Around its edges there are patches of greater reed mace and it is there that the majority of toads spawn.

In all three years there have been several spawning sites and every year three out of the four main areas of reed mace have been used for this purpose.

Besides frogs and toads, one or two newts have been seen as well as fish.

The following is a comparison between the three years :—

1. FROGS

	Arrived	*First Spawn*	*Spawn Abundant*	*Time in water*	*Main Spawning Period*	*Period from arrival to main spawning period*	*Date when all had left*
1952	Mar. 4	Mar. 10	Mar.13	17 days	6 days	9 days	Mar. 21
1953	Feb. 22?	Feb. 24	Feb. 26	9 days	3 days	4 days approx.	Mar. 2†
1954	Mar. 10	Mar. 10	Mar. 11	12 days approx.	2†† days	0 days	Mar. 22

† 1 frog seen on Mar. 5.

†† There was also a second spawning period when not nearly so much spawn was laid. This lasted for 6 days.

2. TOADS

	Arrived	*First Spawn*	*Spawn Abundant*	*Time in water*	*Main Spawning Period*	*Period from arrival to main spawning period*	*Date when all had left*
1952	Mar. 8	Mar. 15 or 16	Mar. 16	14 days approx.	3 days	8 days	Mar. 25 (Last seen on 21st)
1953	Feb. 22	Feb. 24?	Feb. 27?	15 days	3 or 4 days	5 days	Mar. 9
1954	Mar. 10†	Mar. 13	Mar. 17	22 days††	8 days	7 days	April 1

† One or two males arrived on Feb. 23.

†† The total spawning period was 16 days.

From this comparison it seemed that :—

1. Toads were in the water for several days before they spawned.
2. The toads remained in the water for 2-3 weeks, frogs, on the whole, less than this.
3. The main spawning period of the frogs was usually shorter than in toads.

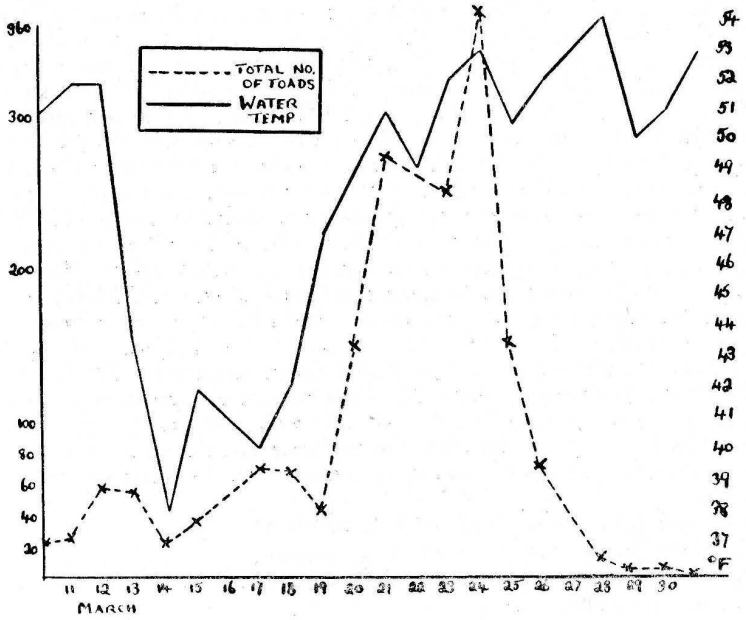

Fig. 1 Graph comparing the number of toads and water temperature.

As was mentioned previously, I did not note the weather in 1952 in detail. Observations were begun on February 28th. For the first few days it was fairly mild, the air temperature being 48-51 degrees F. and the water 46-48 degrees. Then it became very mild and the temperature rose sharply, reaching a climax on March 10th when the air was 56 and the water 54. Then came a steady drop until by the 14th the air was 38 and the water 42. However, it became milder again and remained so for the rest of the time.

Observations were begun in 1953 with the air temperature at freezing point and the water temperature at 35 degrees. It quickly became mild, the air temperature remaining between 45 and 50 degrees and the water from 46-48 until most of the spawn had been laid. Then the temperature steadily dropped, the water remaining about 40 and the air a little lower. It had become a little milder when the last frogs and toads left.

It became clear that the readings taken in 1952 and 1953 were not detailed enough and that only a general idea was obtained. So, in 1954, other readings, which I have already described, were taken.

Observations were begun very early—on January 20th in fact—this being because it was very mild. However, the temperature dropped continually and on January 26th it snowed. Then came a very cold spell, lasting until February 7th. It took several days for the ice to melt, but once melted the water temperature rose steadily. Then for several days the water temperature remained fairly constant, ranging from 43-45 degrees. Then came a slight drop, which was followed by a steady rise, reaching a climax on February 23rd, but the air temperature was already dropping. One male toad was seen and one or two others heard. Unfortunately it was a false alarm because the weather became colder every day and on March 1st it snowed again. However, the snow did not last and the weather slowly became warmer, the water temperature rising as quickly as the air. By March 7th the air had risen to 50 and the water to 49, but there was no sign of any toads. The weather was colder on the following day, but then the water temperature rose to 51 degrees on March 10th. The first toads arrived during the night. Here I had some good fortune because I visited the lake early that morning. It was the warmest night since February 23rd (when the very first males arrived), the minimum temperature being 46 degrees. The night was cloudy, close and damp, and the water temperature at 7.30 a.m. was 46. The wind was very slight. The following night was clear and cold, and as far as I could see no more toads arrived. However, plenty of sun during the day kept the water temperature high (52).

On March 12th I was up at the lake before breakfast again. Although it was coldish in the night the water temperature was 46.5. There were about twice as many toads as the night before and there was a notable increase in the number of females.

The next day it had suddenly become cold, the air temperature being 37, compared with 51 the day before. In spite of this I found one pair of toads spawning and at another site there was one strand of spawn. The following day the temperature had dropped still further, the water being

38. There had also been a snow shower. However, there were eight or nine pairs spawning and considerably more spawn had been laid since the previous day. I am sure there was a decrease in the number of single males. I suppose they had buried themselves in the mud. More spawn was found the following day.

The maximum temperature on March 16th was 39.5, the minimum 35.5. On the 17th it became milder and spawn was abundant. I did the first proper count of all the toads. 63 were counted, 46 were paired. About half of the pairs were spawning.

The temperature rose steadily from the 18th. On the 19th I only counted 40 toads, 28 of which were paired, but the water was rather dirty and I only counted at the two main spawning sites.

But the next morning it was a different matter. 148 toads were counted, 104 of these being paired. The weather had become very mild and except for one day the water temperature (at about 4 p.m.) remained above 50 for the remainder of the spawning period. On March 21st the peak spawning period began. 275 toads were counted. Of these there were 92 pairs and 91 single males. On March 22nd there appeared to be less pairs and more single males, showing that some of the toads had finished spawning. The following day 77 pairs and 99 single males were counted, but this was at 7.20 a.m. It is probable that there were more by 4 p.m. when most of the counts were taken, so that the slight drop in numbers as seen on the graph is a little deceptive. On March 24th the water temperature rose to 53 and the number of toads increased. 366 were counted (101 pairs and 164 single males). On the following day there were only half the numbers, 41 pairs and 67 singles being counted. There was no time to count at one site so there were definitely more than this. On the 26th a full count was made and only 11 pairs and 47 single males were seen. From then the numbers quickly diminished. The very last ones were heard on March 31st.

The frogs were easier to observe in many respects, but they were very elusive and only a very few were ever seen at a time. Even so, the total number was very small compared with the toads. As far as I could see they arrived and spawned on March 10th. There was about twice as much spawn the following day and a little more was laid the next day. Then came a break and I thought that they had all left, but on March 17th a fresh clump was seen at another site and very small amounts were laid on and off until the 22nd.

Thus observations made over these three years showed that both frogs and toads arrived at the breeding site when the temperature was steadily rising and had reached 46 degrees F. or more. A comparatively small proportion of

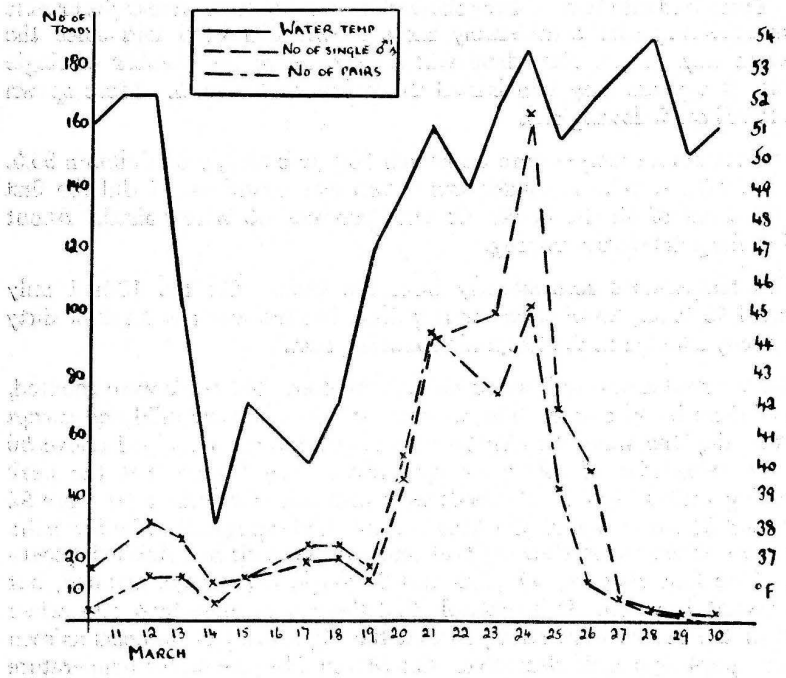

Fig. 2 Graph comparing the number of single males, pairs, and the water temperature.

toads took no notice of the cold weather and continued to spawn, but the majority waited in the mud until the weather conditions became suitable. I believe that most of the toads were in the mud all the time because whenever a large number migrate to the lake some are invariably killed on the road or die of exhaustion, but no males were found dead on the road since they first arrived. There was, however, a small migration of females later.

A summary of the 1954 observations has been made in table form and also a graph showing maximum, minimum and water temperatures.

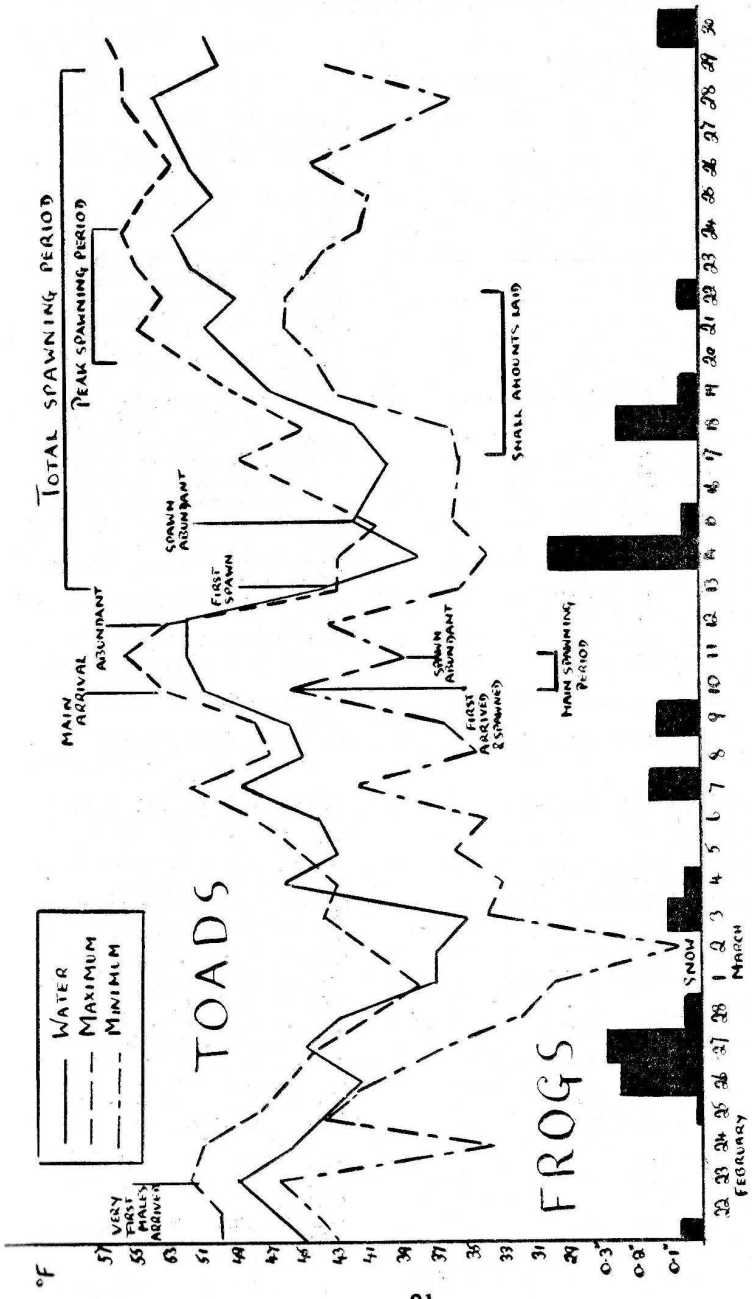

Fig. 3. General observations, 1954

SUMMARY OF 1954 OBSERVATIONS

Date	Air Temperature °F. Max.	Min.	Water Temp.	Rain in.	Males	Pairs	Total	Weather and Notes
20/1	—	—	50	—	—	—	—	Cloudy, dull. Sl. drizzle. V. mild. Strong W.-S.W.
23/1	—	—	43	—	—	—	—	Cloudy, dull, cold, dry. Mod. E. wind.
26/1	—	—	36	—	—	—	—	Snowing. 2-3″ at lake. V. cold. N. wind. (Steady drop in temp. since 20th).
7/2	—	—	36	—	—	—	—	Cloudy, dull, with sleet, becoming mainly fine. Mod.-str. N.W. 2″ ice.
10/2	—	—	36	—	—	—	—	Cloudy, bright per. Occ. showers. Rain in night. Mod.-str. S.W. Milder.
11/2	—	—	38	—	—	—	—	Cloudy, bright per. Dry. Colder. Mod.-str. W.
13/2	—	—	43	—	—	—	—	Fine in morning, showers in afternoon. Mildish. Fixed up rain gauge and max.-min. thermometer.
14/2	—	—	45	0.03	—	—	—	Cloudy, bright per. Sl. N.W.
15/2	46	39.5	44	—	—	—	—	Cloudy, dull, damp. Sl.-mod. wind.
16/2	47	35	43.5	—	—	—	—	Cloudy, dull, coldish, dry. Sl. wind.
17/2	45.5	38.5	43.5	0.01	—	—	—	Cloudy, dull, milder, misty. Mod. S.W.
18/2	48.5	44	45.5	0.27	—	—	—	Cloudy, dull, rain. Dry later. Mod.-str. S.W.
19/2	45	39	42	0.19	—	—	—	Cloudy, dull, showers. V. str. Wstly.
20/2	48	35.5	42	—	—	—	—	Fine. Mod.-str. S.W.
21/2	50	43	45	0.07	—	—	—	Cloudy, dull, misty. Mild. Mod. S.W.
22/2	50	44.5	47	—	—	—	—	Cloudy, mainly dull, dry, mild. Mod.-str. S.W.
23/2	52	46.5	49	—	2-3	—	2-3	Warm and damp in night. Cloudy, mainly fine. Str.-v. str. S.W. Very first males arrived.
24/2	51	33	45.5	—	2	—	2	Ground frost. Cloudy, bright per. Dry. Sl. S.W. Probably no more arrived.
25/2	47.5	44	43.5	0.01	—	—	—	Cloudy, heavy showers. Wind increasing to str.-v. str.
26/2	46?	42?	41.5	0.25	—	—	—	Cloudy, bright per. Heavy frequent showers. Str.-v. str. S.W.
27/2	44.5	36.5	45	0.29	—	—	—	Rain in night. Cloudy, bright per. Showers. Mod. W.-N.W.
28/2	41	31.5	42.5	0.05	—	—	—	Frost. Mainly fine, hail showers later. V. str. W.-N.
1/3	38	30	37	Snow	—	—	—	Cloudy, bright per. at first. Continuous snow later. Mod. N.
2/3	41	22	37	Snow	—	—	—	V. cold in night. Fine at first, clouding over. Heavy rain later.
3/3	44	34	35	0.1	—	—	—	Cloudy, showers. Sl. W. wind.
4/3	43	33	46.5	0.04	—	—	—	Cloudy, bright per. Occ. showers. Sl.-v. sl. N.-N.W.
5/3	45?	36?	43	—	—	—	—	Mainly fine. Sl. frost. Str. N.W.
6/3	48	34	44	—	—	—	—	Cloudy, dull, mainly dry. Milder. V. str. S.W.
7/3	52	42	49	0.16	—	—	—	Rain in night. Mainly fine and mild. Sl.-mod. S.W.

Date	Air Temperature °F. Max.	Min.	Water Temp.	Rain in.	Males	Pairs	Total	Weather and Notes
8/3	47?	34.5	45?	—	—	—	—	Ground frost. Mainly fine. V. sl. wind.
9/3	48	36.5	46	0.12	—	—	—	Cloudy, mainly dry. Sl. variable wind.
10/3	53.5	46	51	—	15?	3	20 plus	Mild throughout night. Mild, cloudy, misty, damp. V. sl. wind. FIRST TOADS arrived). First FROGS arrived and spawned.
11/3	55.5	39	52	—	?	?	?	Fine and v. mild. Cold in night. Mod. S.E. No more arrived I think.
12/3	53	43.5	52	—	30 plus	12 plus	54 plus	Fine. V. mild. S.E. wind. Twice as many toads. Increase in no. of females.
13/3	43	35.5	44	—	25?	12?	49 plus	Cloudy, dull, cold, dry. Cold nthly. winds. FIRST SPAWN (toads).
14/3	43	34	38	0.46	10	5	20	Almost continuous rain. Cloudy, dull, cold.
15/3	40.5	36	42	0.04	12	12	36	Cloudy, dull, mainly dry. Cold.
17/3	49	35.5	40	—	17	23	63	Cloudy, bright per. Milder. Spawn abundant.
18/3	45	36	42	0.23	18?	22?	62?	Cloudy, dull all day. Rain in night
19/3	49	43	47?	0.06	12	14	40	Cloudy, dull. Water dirty. Likely that some were not counted.
20/3	52	44	49	—	44	52	148	Cloudy, dull, later bright periods. Mild. Strong N.W.
21/3	55	46	51	—	91	92	275	Cloudy, bright periods. V. mild. Strongish S.W. Peak spawning per. begun.
22/3	53.5	46	49	0.06	?	?	?	Cloudy, bright periods. Strong S.-S.E.
23/3	?	44	52?	—	99	77	253	Cloudy, bright per. V. mild. V. str. S.W. (Count taken at 7.20 a.m.).
24/3	56	41.5	53	—	164	101	366	Cloudy, bright per. V. mild. Sl. nthly. becoming strong. Spawning at its peak.
25/3	54.5	41	50.5	—	67	41	149	Cloudy, a few bright per. Dry. Mod.-str. S.W. Sharp drop in nos.
26/3	53	44.5	52	—	47	11	69	Cloudy, bright per. Mild. Mod.-str. W.-N.W.
28/3	56?	36?	54	—	6	3	12	Fine and warm. Sl.-mod. S.W.
29/3	56?	43.5	50	—	3	1	5	Cloudy, dull. Rain later.
30/3	57	?	51	0.11	2	1	4	Cloudy, bright per. Dry. Str. S.W.
31/3	56	38	53	0.05	2	0	2	Bright per. Showers. Str. S.W.

Key to abbreviations:
Sl.=Slight. V.=very. Mod.=moderate. Str.=strong. Per.=period. Occ.=occasional.

FROG AND TOAD BREEDING RECORDS FOR 1955

Compiled from the phenological returns 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.

December, 1954: Unsettled, with frequent rain during the first half of the month. Rather cold from the 5th to 13th and around the 24th. Otherwise generally mild. Precipitation above normal in Scotland, N. Wales and North-West England, but below normal in Southern England and Wales and Eastern England. Frequent snow in the North.

January, 1955: Wintry for first three weeks, and then mild. Cold, with prolonged snow from 1st to 4th. Thaw from about the 7th, with temperatures above 50° by 10th. Another cold spell started overnight, with inches of snow over Southern England by the 14th. Very cold until the thaw started with rain and fog on the 20th. Mild cloudy weather after that.

February, 1955: Mild for first week, followed by great cold and snow. Day temperatures only just above freezing by the end of the third week. Rain eventually reached Scotland by the 28th. Sun was associated with the snow showers.

March, 1955: In general, cold and sunny, after rain until the 4th, when it was followed by snow again. By the 10th, fine weather recurred, temperatures reaching normal by the 14th and 15th. Temperatures then fell again, with heavy falls of snow in the North on the 20th. Milder, with rain and flood, from the 23rd to 26th, followed by cold weather again from the 27th. This was accompanied by dry, sunny weather.

April, 1955: Sunny on the 1st, followed the next day by rain, mild weather starting on the 3rd. Increasing warmth until the 20th, although still usually ground frost at night. Cooler from the 21st. Generally dry over England, Wales and Scotland.

Apart from short spells of mild weather, the first three months of 1955 were abnormally cold, so that conditions might have been expected to lead to some abnormal dates of spawning. The mild weather at the end of December is presumably responsible for the earliness of frogspawn in Cornwall (Table 1).

Yet in Devon its appearance is retarded until the middle of March. Correspondingly late dates are to be found in all parts of the country, while there was identical retardation in toad spawn (Table 2). Presumably this lateness and variation in spawn dates from the normal has been responsible for the low number of records this year.

TABLE 1

Main Data from Frog Breeding Records

Locality	*Observer*	*Breeding site*	*Depth*	*Spawn dates*
GUERNSEY				
St. Peter Port (250 ft.)	R. N. Brehaut	Pond	18 in.	9–28
St. Sampson's (25 ft.)	R. N. Brehaut	Pond	12 in.	36
DEVON				
Sidbury (250 ft.)	P. W. Hopkins	Lake	4–6 in.	76–80
CORNWALL				
St. Ives (350 ft.)	L. M. Larkin	Pond	—	–2
SURREY				
Epsom	J. F. D. Frazer	Pond	3–4 in.	76
Dorking	J. F. D. Frazer	Pond	3–4 in.	76–83
Mitcham	G. F. Boyce	Pools	12–15 in.	79–86
Cheam (150 ft.)	R. C. Hinton	Pond	9 in.	86
SUSSEX				
Hastings (75 ft.)	B. Hutchinson	Pond	2–18 in.	94
YORKSHIRE				
Glusburn (450 ft.)	A. Butterfield	Pond A	3 in.	84–86
		Pond B	2 in.	84–91
ARGYLLSHIRE				
Connell (50 ft.)	E. M. Davidson	Bogs	2 in.	68–75
INVERNESS-SHIRE				
Newtownmore (850 ft.)	G. W. Harper	Lochans, etc.	—	90

TABLE 2

Main Data from Toad Breeding Records

Locality	*Observer*	*Breeding site*	*Depth*	*Spawn dates*
DEVON				
Exmouth	A. M. Leadley-Brown	Concrete pond	—	87–90
SOMERSET				
Minehead	M. Green	Marsh dykes	18–24 in.	99
SURREY				
Dorking	J. F. D. Frazer	Pond	12 in.	
Cheam	R. C. Hinton	Pond	12 in.	100
SUSSEX				
Hastings	B. Hutchinson	Pond	2–18 in.	90–94
Horsham	G. N. Slyfield	Lake	18 in.	96
KENT			3 in.	**96-103**
Maidstone	A. M. Tynan	Pond A	18 in.	**94**
Maidstone	A. M. Tynan	Pond B	12 in.	**98**
Maidstone	A. M. Tynan	Pond C		
Loose	R. B. Haynes	Pond	24–30 in.	98
HERTFORDSHIRE				
Baldock	F. M. Wiggs	Pond	18–24 in.	96
Baldock	W. H. Fordham	Pond	18 in.	99–101
HUNTINGDONSHIRE				
Kimbolton	O. N. Bishop	Pond	12 in.	101

The spawning of frogs in Cornwall on December 30th proved even earlier than the first record from Guernsey (R. N. Brehaut), where the two spawnings occurred at temperatures above 40°F. (Figure 1). In the case of the Scottish spawning represented in Figure 2 (E. M. Davidson), this is again associated with a mean temperature of 40°, the maxima reached being 48° on the two dates indicated. Both the first spawning and the peak abundance occurred after a rise in the temperature, while no rain had fallen for several days before the first spawn was laid.

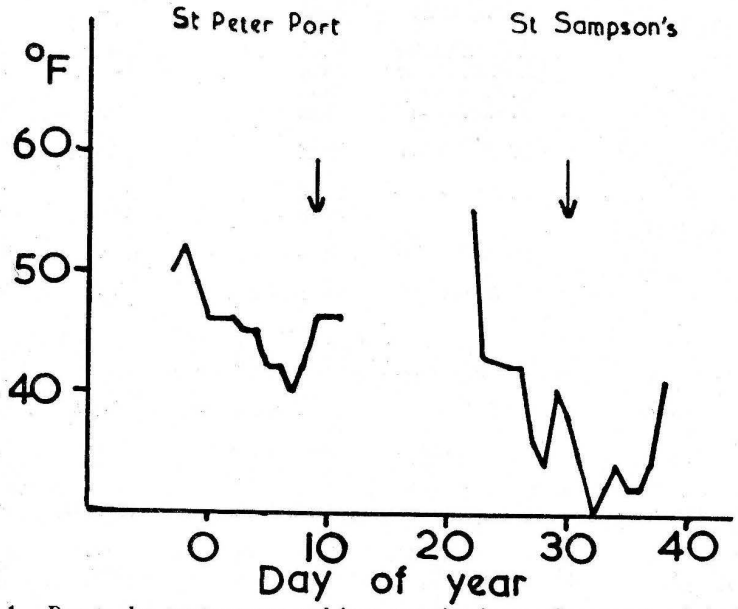

Fig. 1. *Day to day temperatures and frog spawning in two Guernsey ponds in* 1955 *(R. N. Brehaut). The arrows indicate dates of spawning.*

Similar findings occur in Figure 3, which depicts details of frog and toad breeding in two ponds at Cheam (R. C. Hinton). The frogs spawned here when the temperature was fluctuating between 45° and 62°, immediately after a rapid rise, which was associated with rain. This seems to give the clue to the influence of rain, since this is frequently associated with a rise in temperature. But such rises can occur without any rain. The toad spawning took place after a less spectacular rise in temperature, at a time when this was varying from 43° to 63°. These toad results were obtained from a colony of minimal size, only three females and one male being present, the male mating with two of these females in turn. A frog paired with the third female, but they left the water without any eggs being laid.

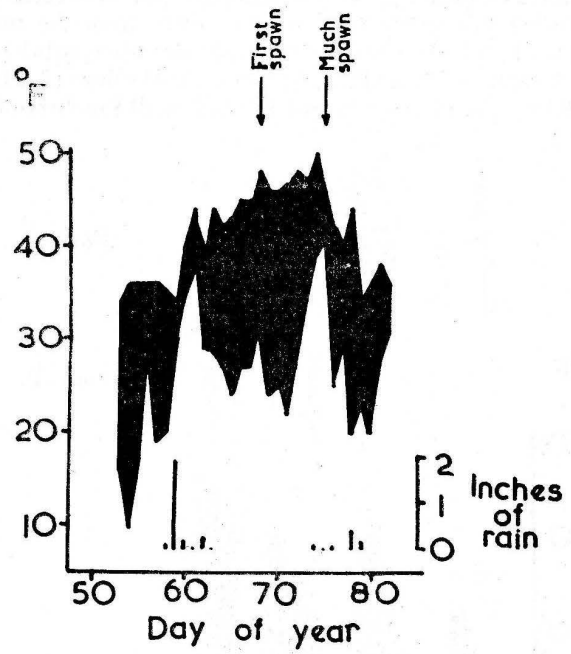

Fig. 2. *Temperatures (range from maximum to minimum) and rainfall at Connel, Argyllshire, during the spawning period,* 1955 *(E. M. Davidson).*

Further toad results are given in Figure 4 (A. M. Leadley-Brown), where a close watch on a pond at Exmouth has revealed that male toads appeared in the pond early in February, when the air temperature was fluctuating but had been between 44° and 48°F. This was immediately followed by a cold spell, when ice formed on the pond and all the toads disappeared. It is not known whether these left the water or buried themselves in the mud, although the latter is very probable. Reappearance of toads, apart from two or three individuals, did not occur until there was a sharp rise in both land and water temperatures about the middle of March. Peak numbers were in the pond with the water temperature fluctuating from 48° to 51°. Exact temperatures are unfortunately not available for the date of first spawning, but spawn only became plentiful when there was another sudden rise in the water temperature following a drop. Thus the picture once again falls in with the idea that spawning is dependent on temperature, as is also the migration of toads to the breeding site. Minimal water temperatures above 40°F. seem to have been necessary for the start of spawning.

It must be emphasised that only a small number of records have been received covering this season, none having come from the mainland of Europe or from Israel. In some cases, the absence of records has been due to the non-appearance of breeding amphibia. At Hastings (B. Hutchinson), only about four pairs of frogs turned up and small numbers of ova were

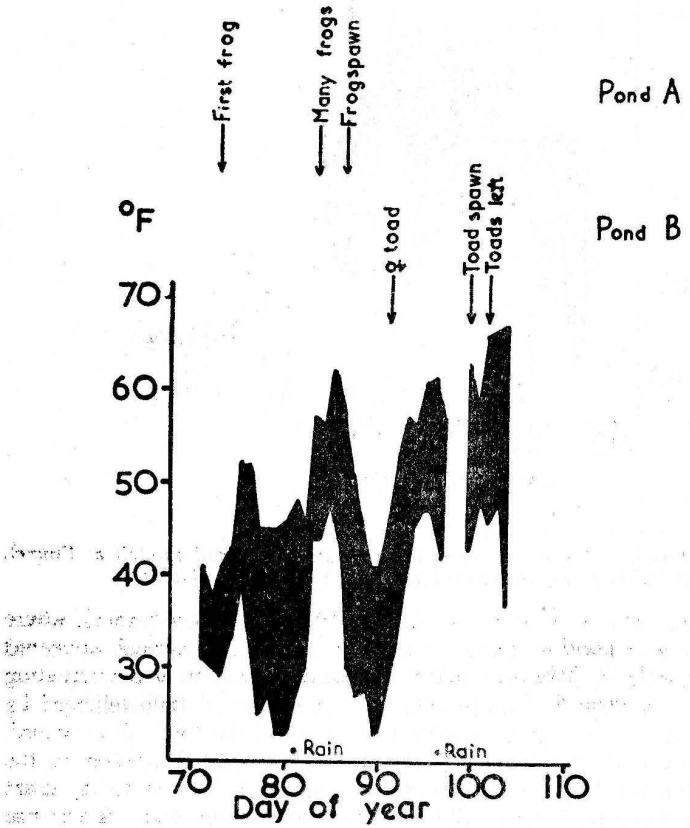

Fig. 3. *Temperatures and rainfall at Cheam, Surrey, during the spawning period,* 1955 (*R. C. Hinton*).

laid, some four days *after* the toads had spawned. This may be some local peculiarity, as toads spawned here before frogs both in 1952 and 1953. In 1954, frogs were not seen there, but some spawn is believed to have been produced at about the same time as the toadspawn.

In conclusion, I should like to thank all those who have supplied the data from which this phenological report has been compiled.

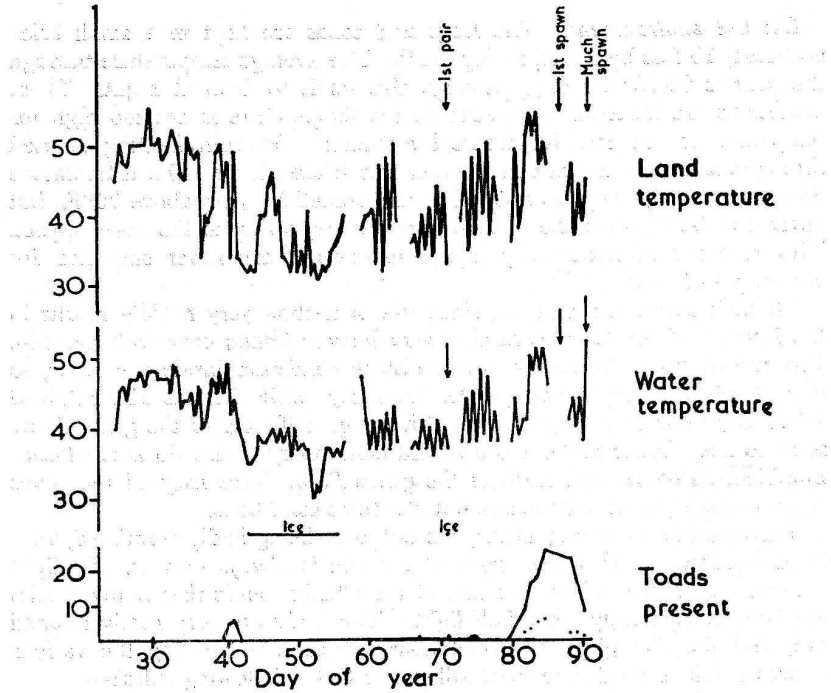

Fig. 4. *Land and water temperatures at Exmouth during the toad spawning period,* 1955 (*A. M. Leadley-Brown*). *The numbers of toads in the pond are shown below, males being indicated by a continuous line, and females by a dotted one.*

THE KEEPING OF AMPHIBIA

By N. WHITE

General environment. The frogs and toads are kept in a small brick outhouse, 10 feet by 9 feet, facing north. The average temperature through the year is 65-70° by day, although this tends to drop at night. These conditions are ideal for all species as the temperature is not too high for temperate or too low for tropical creatures. Paraffin heating is used throughout the winter, but in summer this is abandoned: the temperature then occasionally drops to about 60° and sometimes goes above 70°F., but never gets hotter than the outside temperature, owing to the north aspect. This means that abnormally high temperatures are never sustained for any length of time.

All tank covers are of glass, since use of netting very rapidly results in the interior of the tanks becoming very heavily filmed over with paraffin. The use of glass also means that moisture condenses inside the tanks, so that there is a very much greater humidity, while heat is also retained inside any tanks requiring individual heating. All frogs of the genus *Rana* seem to keep better under more humid conditions, as also do *Discoglossus, Bombina, Pelobates* and toads of the genus *Bufo*. Tree frogs of the genus *Hyla,* however, seem to do less well under these conditions.

The conditions are very crude, the outhouse being badly ventilated, with fixed windows, so that the odour of paraffin is always present. Sunlight is never available, and the position of their tanks means that many species are kept permanently in a half light. The tanks are very rarely cleaned out, and the diet given is monotonous. Success in keeping the various species is felt to be due to strict adherence to the following rules:—

1. Temperature is never allowed to drop below the standard minimum.
2. Feeding is regular and plentiful.
3. Tanks must never be overcrowded. A minimum of 50 square inches of space is allowed for specimens 2-3½ inches in body length, this being modified for smaller or larger specimens.
4. Different species are kept separately, where possible, even if this may mean devoting a whole tank to one worthwhile specimen.
5. Once a new specimen becomes settled and content in any environment, it is kept permanently in that tank under this some conditions. Until it is happy, experimentation with the environment must be tried; but once it is happy, needless changes may completely undo good results.
6. All newly acquired specimens are quarantined for 6 weeks, and are only then placed in any tank containing good stock if they

are still in as good condition (or better) as when received. This is of extreme importance.

The furnishing of tanks is kept down to a bare minimum. Deaths can thus be readily noticed in time to remove the corpse before decay has started. Tanks are made up with varying proportions of land and water (50-50, 75-25, 25-75) the land being made from gravel sloping into the water, or with 2 inches of water over a level gravel bottom, or divided so as to give equal proportions of mud and water. Hideouts may or may not be present, according to the species. Water and moss are changed every month or every three months, according to type of cage, while water bowls are changed every two weeks. Entire cages are cleaned out every six or twelve months. All this cleaning is done by rota. Paraffin is wiped from the outside glass of all tanks every month.

Heating

Points about the use of paraffin are:—

1. The odour, if disliked, can be minimised by putting mothballs into the store can.
2. By using glass covers to tanks, the entry of paraffin is very slight.
3. Effect of paraffin on the livestock is negligible. Frogs have survived two winters of this heating.
4. The humidity of the air is not affected by this fuel, unlike others which tend to dry it out.
5. The fuel is reliable, comparatively cheap, and not subject to power cuts.
6. Various temperatures can be used, by adjusting the rate of burning.
7. Only comparatively little light is given out (which does not affect the depth of darkness at night.
8. A reserve stove can always be ready in case of a failure of the one in use.

Two stoves of the "Valour" type are used, the second one being lit only if the outside temperature is below 37°F. Temperature can be controlled by variation of the height of the flame according to the weather. With the flame full on, a newly-filled stove burns for some 15 hours, so that one regular filling at 8 a.m. and another at 8 p.m. will keep it running day and night through the winter. If the flame be blown out instead of turned off when refilling is taking place, the wick will very rarely need trimming.

If additional heat is required for tropical creatures, small round flat "Buflam" lamps are placed beneath their tank. These burn for seven days on one filling of two pints, and will produce additional heat up to 80°F. on even the coldest day. A sheet of slate or asbestos should be placed directly below the tank, with the lamp turned low about 2 inches below this.

Consumption of paraffin during the winter, with one large and four small stoves in use, should be about six gallons of paraffin per week, and much less in mild spells.

Feeding

New arrivals are given as much food as they can possibly take for two or three weeks, until they are in good "fat" condition. They are then treated in the same way as old stock.

Virtually only three forms of food are ever used—worms, blowflies and gentles.

1. Worms. All frogs and toads (other than bullfrogs) which will take worms readily are fed one or two every week. Bullfrogs (*Rana catesbeina, adspersa, tigrina, grylio* and *heckscheri*) are fed an average of one worm a day. Worms are never just dropped into the cage and left (since such worms merely find their way down to the bottom and remain there until the tank is cleaned out), but care is taken that each creature eats its worm. In cases of refusal, the worms are removed.

Worms are usually available throughout the year when collected at night by flashlight. They are usually present in profusion at any time of year when the ground is wet from recent rain, and especially on a fairly windless evening about an hour after dusk, at around 45°—50°C. A weak light should be used. After long spells of drought, it may take two or three days before the worms reach the surface after rain. Close-cropped lawns are the easiest to work, and the nearest large public one or verge should be used.

In either drought or frost, worms should never be unobtainable for longer than a month. Surplus ones can be stored for weeks in cans containing completely dry old leaves and a piece of dry moss: the moisture of newly-caught worms will keep this damp enough. No earth should be used. Always divide your stock amongst a number of tins in case of disaster to some. Only entire and undamaged healthy worms should be stored. These should be sorted from the others one day after catching, all doubtful ones being used immediately as food. Examine the cans every few days for dead worms, which can be detected by their smell.

If the stock of worms is completely exhausted and there is little chance of replacement, then (and only then) will snails have to be used for bullfrogs and *Bufo marinus,* which will only take these when shelled. The best method is to hit them against a brick, and then peel off the pieces under water in a small bowl. Care should be taken to remove the small jagged bit of shell which often remains at the centre of the snail. In the event of neither worms nor snails being available, the large species can be fed on strips of fish or raw meat, which can be dropped in front of them and agitated with a stick. Fish (especially fresh water ones) are preferable to meat: strips should be on the small side, as frogs often get into difficulties with larger pieces.

2. Blowflies. All creatures which will not take worms (*Hylidæ,* etc.), are fed twice a week on flies, and all those which receive worms once a week are given flies once a week, midway between their meals of worms. Flies are not given to *Rana adspersa, catesbeiana* and *tigrina* at all, owing to fear of their injuring themselves while leaping after flies.

3. Gentles. All those animals which take neither worms nor flies are fed on gentles twice a week, of which a regular supply is obtained weekly. A small quantity of very little gentles is supplied with the others each week, and these change into very small flies, which prove an invaluable food for very small species which would otherwise require the labour of breeding fruitflies.

Flies are bred from the gentles in about 3½ weeks from the time of receiving them. After taking the gentles required for immediate feeding each week, the rest are shared out between a set of 15 jam-jars and left to pupate. The jars have cloth covers, so as to prevent the flies from being too moist on emergence. Four sets of jars are used in rotation.

NOTES

NOTES ON REARING THE PLEURODELE NEWT

By

A. Hayward and F. C. Katritzky

This large Spanish Newt (*Pleurodeles waltl*) laid its eggs singly on the water weeds on 28th February. The weed was then placed in a tank of pond water in the front of my greenhouse in full light.

The young newts left the egg cases between the 9th and 11th March and measured $\frac{1}{8}$ inch long. They soon developed gills and moved around the bottom of the tank feeding on small Daphnia and Cyclops. By the 22nd March they had developed their front legs and measured $\frac{3}{8}$ inch long, after which time they could be seen coming to the surface and taking gulps of air. On the 26th March their length was $\frac{1}{2}$ inch.

By the 30th March they were taking White Worm for food, and by the 4th April their back legs could be clearly seen. They were completely grown by 17th April when the young newts measured $1\frac{1}{2}$ inches in length.

The newts metamorphosed from 10th May onwards and the first one was seen to leave the water on 29th May. At this time their food was garden worms, and their length 3 inches.

Although these newts appear more aquatic than our common ones, they do like to leave the water for long spells. They do not like very bright conditions and will hide away under rocks if able, so the tank is usually kept now in semi-shade.

Summary of Development

Egg—tadpole ...	9—11 days.
Front legs	11—13 days.
Hind legs showing...	22—24 days.
Grown to $1\frac{1}{2}$ inches	37 days or approx. 5 weeks.
Metamorphosis ...	60 days or approx. 8 weeks.
Leaving water ...	100 days or approx. 14 weeks from egg laying.

DEATHS OF TESTUDO ELEGANS FROM INTESTINAL OBSTRUCTION

I learned earlier this year from Ceylon that a number of young specimens of the tortoise, *Testudo elegans,* were found dead in their natural habitat from no apparent reasons. On my request five specimens which were found dead and a sixth which was nearly dead, were sent to me. As a result of examining all the specimens my attention was drawn to the unusual form of the posterior end of the intestine which was considerably over-distended. Further examination revealed obstructions of a hard nature impeding the passage of the fæcal matter. When pressure was applied behind the obstruction it did not move further down the intestine. If considerable pressure was exerted, the intestinal wall would begin to rupture.

On opening the intestine the objects forming the obstruction in all the specimens were seeds of the plant *Curica papaya L.,* which is widely cultivated in Ceylon. The seeds which were nearly all of the same size, 5.5 x 4 mm., averaged three in number for each tortoise, although one specimen, the intestine of which had been ruptured, contained five seeds. The external surface of the papaya seed being covered with small barbs further aids obstruction.

As papaya seeds have been found in the fæces of larger specimens of this species, it is evident that obstruction is caused by the seeds only in the small specimens measuring less than six inches in length.

Timothy J. Hunt.

CORRESPONDENCE

17*th December,* 1955. Clayden, Streatham Rise, Exeter, Devon.

In connection with the paper by H. J. Moore on toad migration* I should like to draw your attention to a point arising from the table of observed night weather in relation to movement (Table 6).

I had always thought it self-evident that toads migrate in humid conditions, and this point is made in the paper. However, while the great majority of moves are made in mild wet weather as indicated by these corpse counts, the markedly greater numbers of road accidents occurring on mild dry nights compared with cold dry, suggests that the principle aspect of the weather causing this movement is temperature rather than humidity. I should be interested in any other information relating to the precise nature of the external stimuli to movement.

The following table gives the number of corpses per day recorded in each year, expressed as per cent. of the total after compensation for the different proportion of each type of weather. These figures cannot, of course, give more than a rough indication of the situation because of the number of variables involved, but the difference between the numbers killed on cold dry and mild dry nights is great enough to be significant. The only discrepancy seems to be the large numbers moving in cold wet weather in 1953 which on this interpretation would not be expected, but this may be due to the small number of mild dry days or to some other, perhaps internal, factor having more influence than climate.

Type of Weather	*% Number of deaths between Jan. 17 and Mar. 30*		
	1951	1952	1953
MW	70.7	82.1	31.9
MD	20.4	15.4	16.7
CD	1.8	2.5	0.6
CW	7.1	0	50.8

* Some observations on the migration of the toad (*Bufo bufo bufo*), *British Journal of Herpetology*, I. II. 194.

Yours, etc.,

L. M. Cook.

REVIEW

"REPTILES OF WEST AFRICA" by George Cansdale, 1955.

(Penguin Books, West African Series).

104 pages : 8 figures each with 4-6 subjects.

This is the first English book on West African snakes, apart from Frank Leeson's laboratory manual on "The Identification of Snakes of the Gold Coast". The writer has the advantage of being a born field collector who not only handled most of the species he describes, but knows how to make them interesting to his readers. Even a reader without West African experience would read this book with profit and learn much about reptiles thereby. If he combined his reading with visits to Reptile Houses, particularly at the London Zoo where Mr. Lester has done so much to enrich the West African collections, the reader could learn much.

The illustrations are good and the style of writing is easy and instructive. After an introductory chapter, there are chapters entitled—"Mainly Harmless Snakes", "The Dangerous Snakes", "Lizards", "Crocodiles", "Tortoises and Turtles", with a short bibliography and a list of scientific names of the reptiles described, at the end of the book. F. R. Irvine.

The College Press, 31 Dulwich Village, London, S.E.21