thalamic or peripheral receptors. Moreover, since adrenaline is present and, presumably, is metabolized in the brain, it must be formed there from precursors which cross the blood-brain barrier (*10*).

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Preliminary Identification of Crystalline Phases in a Transparent Stalactite

Abstract. Of two crystalline phases found in a cavern stalactite, the major phase is mirabilite, whereas the minor phase, according to preliminary data, is a new mineral, sodium hemicalcium sulfate dihydrate, which is unstable at temperatures above 25°C.

In 1955 W. T. Austin and J. J. Lehrberger explored and documented photographically a series of new passages in the Flint Ridge Cavern system of south-central Kentucky. A number of spectacular, glasslike stalactites were found in one of the passages. When specimens collected from these deposits were taken above ground, they effloresced and melted. Hence, to obtain material for the study described in this report, two samples were transported to the laboratory under a cool atmosphere saturated with water vapor.

Both samples consisted chiefly of a transparent material that occurs in short prismatic crystals showing a vitreous luster and a conchoidal fracture. About 1 percent of each sample was made up of a second substance somewhat less transparent and occurring in monoclinic needles.

The major phase was extracted from the mineral sample with ice water. After the insoluble minor phase had been removed by filtering, the filtrate was found to contain only Na^+ and SO_4^{--} ions accompanied by traces of Ca, Si, Mg, and Al; these elements were detected with a spectroscope. The observed melting point of the major phase was 33° to 34°C (sealed capillary). Accordingly, the water-soluble phase present in the stalactite is unquestionably mirabilite ($Na_2SO_4 \cdot 10H_2O$), which melts at 32.4°C; This finding was confirmed by measurements of the index of refraction and specific gravity. The observed value for the refractive index was 1.40 [literature value, 1.36 (*1*)], and the observed value for the specific gravity was 1.46 [literature value, 1.48 (*1*)].

A sample of the minor phase suitable for analysis was obtained by grinding the gross specimen to a fine powder, extracting the soluble major phase with an ice-cold alcohol-water mixture, and finally collecting the insoluble solid on a weighed, sintered glass filter. The weight of the minor phase indicated that it was originally present in the stalactite to the extent of about 1 percent. The weight loss obtained by heating the insoluble fraction to constant weight at 125°C (in a vacuum) indicated that the minor phase contains between 7.9 and 8.0 percent bound water. The anhydrous salt was found to be somewhat soluble in water and was readily soluble in dilute hydrochloric acid. The acid solution was found to contain only Ca^{++}, Na^+, and SO_4^{--} ions along with traces of Al, Mg, and Si (detected by spectroscope).

Two naturally occurring double sulfates of sodium and calcium are recorded in the mineralogical literature: These are glauberite ($Na_2SO_4 \cdot CaSO_4$) and ciempozeulite ($3Na_2SO_4 \cdot CaSO_4$), both of which are anhydrous salts. Therefore, a quantitative measurement of the Na : Ca ratio was necessary to ascertain whether the minor phase was a hydrated modification of those double salts or another mineral. A conventional determination of both elements gave a Na : Ca ratio of 3.821, which is not in agreement with the Na : Ca ratio of either glauberite (theoretically Na : Ca = 2.00) or ciempozeulite (theoretically, Na : Ca = 6.00).

Hill and Wills (*2*) have made a study of the ternary system $CaSO_4$-Na_2SO_4-H_2O at 25°, 35°, 50°, and 75°C. They obtained a labile sodium hemicalcium sulfate ($2Na_2SO_4 \cdot CaSO_4 \cdot 2H_2O$) from the action of gypsum on an aqueous solution of sodium sulfate. Upon standing, the solution becomes filled with long, slender needles which are so closely knitted together that as little as 1 percent of the labile salt will hold the mass in suspension, so that no movement occurs when the reaction vessel is inverted. The calculated Na : Ca ratio for Hill and Wills' metastable salt is 4.00, which is in fairly good agreement with the value of 3.821 obtained for the minor phase of the stalactite. The measured refractive index of the minor phase is 1.518, which compares favorably with the value of 1.510 observed by Hill and Wills for their metastable salt.

On the basis of the observed Na : Ca ratio, water of hydration, refractive index, and the weight ratio between the major and minor phases, it is tentatively suggested that the minor phase is identical with the sodium hemicalcium sulfate dihydrate described by Hill and Wills. The somewhat low Na : Ca ratio and the slightly high refractive index can best be explained by the probable presence of a very slight excess of calcium sulfate in the mineral specimen taken for this preliminary study.

The labile salt described is metastable with glauberite within the temperature range of 25° to 75°C (*2*) and is, therefore, stable at the cavern temperature (12° to 15°C). At temperatures above 25°C, the reaction

$$2Na_2SO_4 \cdot CaSO_4 \cdot 2H_2O \rightarrow CaSO_4 \cdot Na_2SO_4 + Na_2SO_4 + 2H_2O$$

would account for the conversion of the minor phase to an equilibrium mixture of glauberite and thenardite (*3*).

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3. This work was carried out under the auspices of the Cave Research Foundation and is Cave Research Foundation contribution No. 3. I acknowledge the assistance of R. W. Brucker, with whom I discussed the stratigraphy of the Flint Ridge Cavern system, and of Carl W. Melton, who measured the index of refraction. A more complete description of this mineral, which will include the results of analytical and crystallographic investigations, is in preparation.

12 March 1959

Occurrence and Morphology of a Phenotypic Male of a Gynogenetic Fish

Abstract. A phenotypic male of *Mollienesia formosa,* a gynogenetic fish, has been collected at Brownsville, Texas. The male and female fish are essentially similar, and their morphology supports a hypothesis that the species is of hybrid origin.

Many workers have demonstrated the occurrence of gynogenesis—activation of unfertilized eggs by sperms with the removal of paternal chromatin during early cleavage of the resulting offspring (*1*).

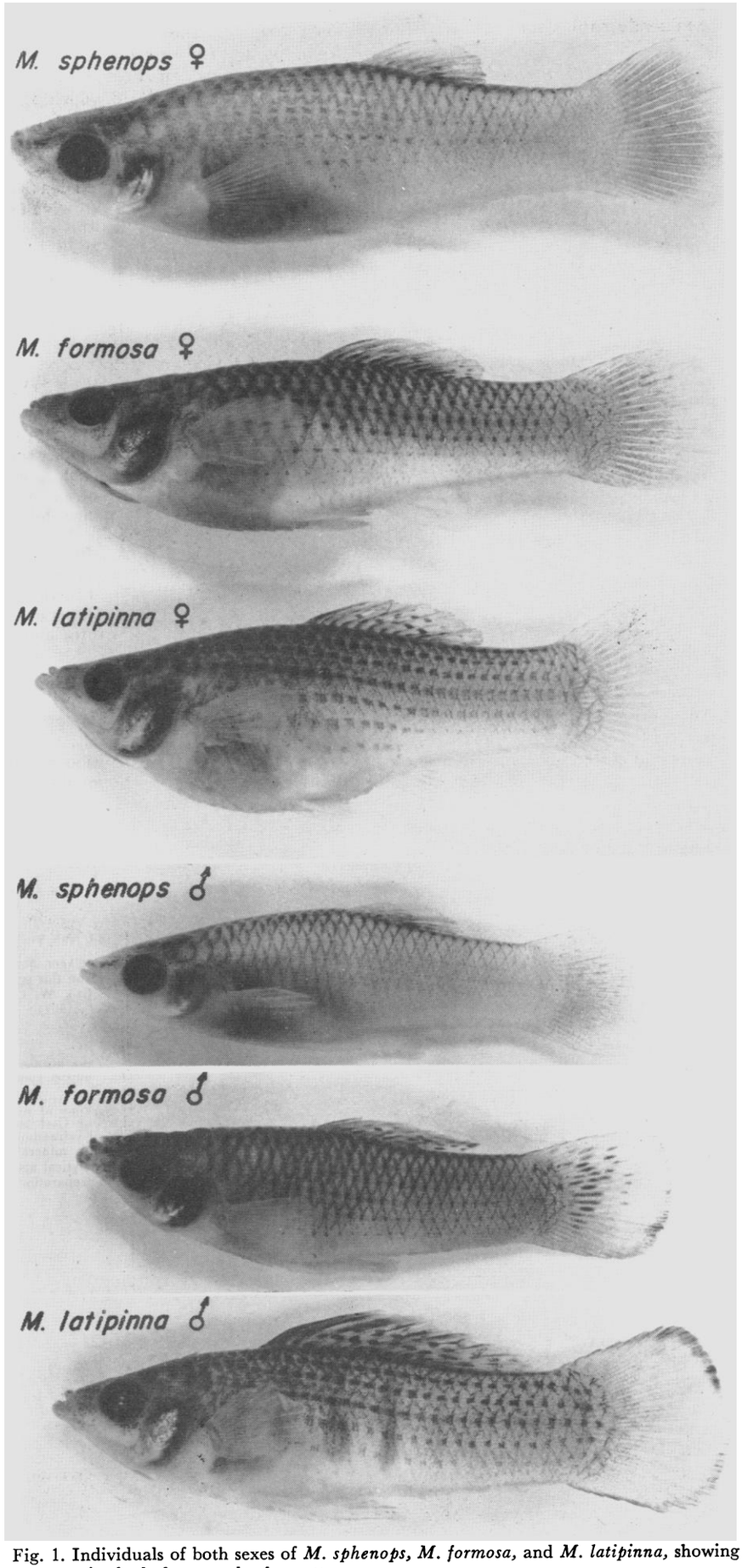

Fig. 1. Individuals of both sexes of *M. sphenops, M. formosa,* and *M. latipinna,* showing comparative body forms and color patterns.

Only a small fraction of the examples concerns species in which gynogenesis is the normal mode of reproduction. The sole known example in vertebrates is *Mollienesia formosa* (Girard) (*2–4*), a fish living in northeastern Mexico and southern Texas. Meyer (*5*) considered that the nucleus of *M. formosa* includes male chromosomes which are totally inactive and are eliminated during the following meiosis. This difference of interpretation regarding details of the mode of inheritance has not been resolved; however, the morphologic presence but functional absence of paternal chromatin differs little from the mechanism of gynogenesis. Females of *M. formosa* produce broods after they are placed with mature males of many related species, but virgin females never do (*2, 3, 5*). None of these broods include males, and all offspring are replicates of their mothers (*6*). In nature the *M. formosa* females uniquely make use of related species, *M. latipinna* LeSueur and *M. sphenops* (Cuvier and Valenciennes), utilizing sperm from these males to stimulate development.

On 14 August 1958, we and others from the University of Texas Institute of Marine Science, with the aid of a local Baptist Sunday-school class, sampled *Mollienesia* in the vicinity of Brownsville, Texas. These collections were examined in the laboratory, and one was found to contain a phenotypic male of *M. formosa.* The pertinent collection was obtained from a drainage ditch ½ mi west of Brownsville International Airport. This collection included 1108 females of *M. formosa* as well as 30 females and 11 males of *M. latipinna.* The obviously one-sided sex ratio of *M. formosa* is in agreement with the previous work on this species. The sex ratio of *M. latipinna* probably results from high male mortality typical of these and related fishes (*7*).

There is little doubt that this phenotypic male fish is either an F_1 hybrid between *M. sphenops* and *M. latipinna* or a male of a previously all-female gynogenetic species. As laboratory-produced F_1 hybrids and masculinized females cannot be distinguished morphologically (*8*), it is not possible to ascertain without doubt which of the alternative possibilities is correct. We tend to discount the possibility that the fish is an F_1 hybrid. *Mollienesia sphenops,* one of the suggested parent species, is not known to occur in the vicinity of Brownsville. The nearest localities where it has been found are China; Nuevo León, Mexico (more than 150 miles from the collection locality); and the Río San Fernando (separated from the collection locality by the open ocean). As related fishes are known to remain within limited areas during their entire life span (*9*), it is not likely that this male or one of its

Table 1. Characteristics of three species of *Mollienesia*. Averages are given, with the range in parentheses.

Sex	*M. sphenops*	*M. formosa*	*M. latipinna*
	No. of dorsal rays		
F	9.0 (9)	11.2 (10–12)	13.4 (13–14)
M	9.0 (9)	11	13.4 (13–14)
	No. of scale rows between dorsal and occiput		
F	12.0 (12)	10.5 (10–11)	8.6 (8–9)
M	11.5 (11–12)	9	7.1 (6–8)
	No. of pectoral rays		
F	15.1 (14–16)	14.6 (14–15)	13.2 (13–14)
M	15.0 (14–16)	14.0 (14)	13.1 (12–14)
	Ratio of predorsal length to length of dorsal base		
F	4.69 (4.5–5.0)	2.73 (2.6–2.9)	1.88 (1.8–2.1)
M	3.84 (3.3–4.1)	2.34	1.36 (1.2–1.7)

parents wandered many miles during its life span. We also doubt that one of its parents was released by a tropical-fish hobbyist. If this fish is an F_1 hybrid, it is the sole known natural hybrid of a combination thought to have resulted in the formation of *M. formosa*.

The male was compared with 10 females of *M. formosa* and with 10 of each sex of *M. latipinna* from the same collection. It was also compared with six males and 10 females of *M. sphenops* from the Río Pánuco system in Vera Cruz, Mexico. It resembles the females of *M. formosa* in traits not normally sexually dimorphic in *Mollienesia* (see Table 1, number of dorsal rays and pectoral rays) and differs from the females just as males of the other species differ from the females (see Table 1, scale rows between dorsal origin and occiput and ratio of predorsal length to length of base of dorsal fin).

The male also resembles females of *M. formosa* in color pattern (Fig. 1). Both male and female have lateral spotting intermediate between that of the spotted *M. latipinna* and the almost plain *M. sphenops*. Both have the caudal base mottled, in contrast to the clear caudal base of *M. latipinna* and the dusky base of *M. sphenops*. The dark caudal margin of the male is weak, whereas in the male of *M. latipinna* the dark margin is well developed and in males of *M. sphenops* the caudal margin is clear.

In body shape the male is intermediate between the robust *M. latipinna* males and the slenderer males of *M. sphenops*. Similarly the gonopodial structures of the male are intermediate between those of *M. latipinna* and those of *M. sphenops*. The serrae on ray 4p extend two segments beyond the tip of the spines on ray 3 in males of *M. latipinna*, one segment beyond in the male *M. formosa*, and to the tip of the spines on ray 3 in males of *M. sphenops* (*10*). The spines of the gonopodia in *M. latipinna* are equal in length to the basal elements and are strongly curved toward the fin base; in *M. formosa* they are slightly longer than the basal elements and are gently curved, and in *M. sphenops* they are much longer than the basal elements and are very nearly straight. The consistently intermediate position of the *M. formosa* male supports a hypothesis that the species originated as a hybrid between *M. sphenops* and *M. latipinna* (*2, 4*). The *M. formosa* male is extreme with respect to the suspected parental forms only in having the largest gonopodial hood. Such extremes do occasionally occur in known hybrids (*11*). Its morphology bears the same position relative to that of the suspected parental forms as does the morphology of other natural fish hybrids relative to that of their suspected parental forms (*4*).

The effect of rare natural males on wild populations of *M. formosa* as well as the mechanism by which these fish developed male reproductive organs is an interesting field of study. Unfortunately this male was preserved in the field (because of the large sample and the knee-deep mud at the sampling station). It was therefore impossible to ascertain the effects of its chromatin in crosses with females of its own species and with females of related species. Microscopic examination of the gonad shows the milky white smooth texture typical of testes of related species, without any of the yellow tinge or granular texture typical of females. As the gonopodium is somewhat opaque at the tip, the male is believed to have been nearing maturity.

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13 November 1958

An Approach to Quantifying Various Types of Spontaneous Activity

Abstract. The output of an activity-measuring device is fed into low- and high-gain cumulative recorder channels which are reset to zero after different time periods. The records, inscribed at various paper speeds, are easily quantified. The tracing patterns can be identified with specific activities of undisturbed animals. The activities are monitored by means of closed-circuit television.

The quantity and quality of spontaneous behavior, simultaneously measured, should be sensitive indicators of the effects of physiological, psychological, and pharmacological procedures. Unfortunately, the techniques generally used to ascertain the random activity of animals yield either a single number or a kymographic record of the pattern of activity (*1*) which is difficult to quantify. A start toward solution of the problem of obtaining precise information on both parameters simultaneously has been made by combining a specially designed cumulative recorder that indicates the interruption of a light beam across the animal's cage (*2*) with closed-circuit television.

The recorder, a modification of Skinner's design (*3*), has several distinctive features. (i) The same input feeds simultaneously into a low-gain channel and into a channel with a gain which is 10 to 50 times that of the other. To obtain the records shown in Fig. 1, the low-gain channel was set at 500 light-beam interruptions, full scale, and the high-gain channel at 50 interruptions, full scale. (ii) Reset to zero is based on elapsed time rather than on accumulated number; the low-gain channel is reset every 15 minutes and the high-gain channel, every 0.5 minute. As a result of this feature, the height of the line gives a num-