percent of the time. Thus it was between 0.6 and 0.7 second after initiation of a whistle that chorusing became most evident.

The two animals emitting contours 3 and 4 (Fig. 1F) responded simultaneously to termination of another's whistle (contour 2); the simultaneous response began at 0.41 second, and at 0.8 second contour 4 abruptly terminated, rather than extending the normal duration. Two percent (46) of all analyzed whistles showed this abrupt cutoff; all but one occurred when two animals responded almost simultaneously to a known outside stimulus.

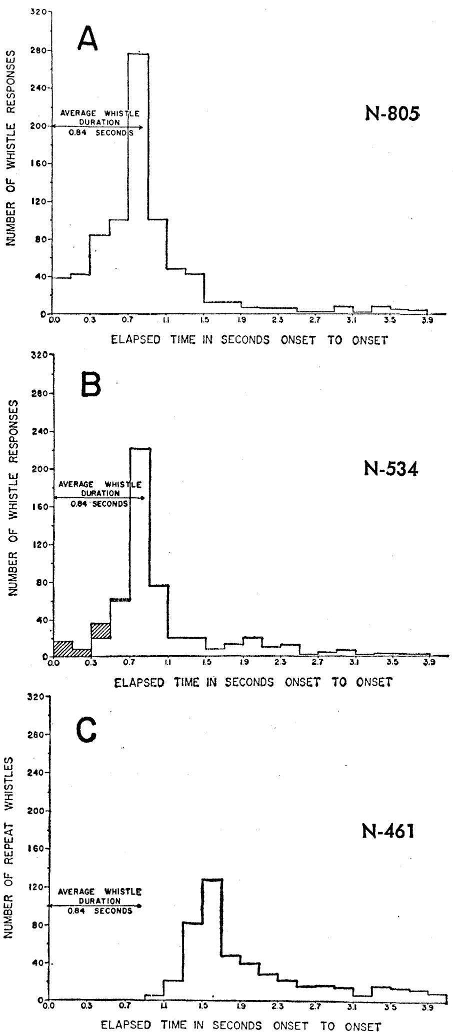

Fig. 2. Captive common dolphins. (A) Time intervals between initiation of a whistle by one individual and elicitation of a whistle from a second individual; taken from analyses of whistles by a group of four. (B) Same; taken from analyses of whistles made by a group of three of the original four; each cross-hatched area indicates number of times that one of the two remaining animals abruptly terminated its normal (fully contoured) whistle. (C) Time intervals between signature whistles repeated by same animal; graph represents only whistles that either were repeated or had not elicited an intervening response within 4.1 seconds.

The animal emitting contour 3 accounted for 61 percent of the cutoffs, while the two highly vocal animals emitting contours 1 and 2 accounted for only 9 percent each. Thus differences appear in this aspect also of *Delphinus* vocal behavior: some individuals tend to defer more readily than others.

Whistles were frequently repeated without an intervening response by another animal. A mode is apparent between 1.6 and 1.7 seconds from onset of a whistle to onset of a repeat emission (Fig. 2C). This finding signifies a modal value of about 0.8-second delay before a whistle is repeated, because the average duration was about 0.84 second. Seventy-nine percent of all repeat whistles occurred within 1.7 seconds of termination of the preceding one.

Almost all small toothed whales that we have investigated emit in addition to contoured whistles a brief pure-tone chirping sound, usually with a short, sharp upsweep. This sound was emitted in frequent bouts by the *Delphinus* when first captured; it was usually accompanied by emission of a pulsed sound of a soft, grating quality (Fig. 1G). At times the chirp was omitted and rapid "barking" bouts ensued (Fig. 1H). Each "bark" was a burst-pulse sound similar to those made in emotional contexts by other odontocetes (*5*). All these sound emissions became most constant prior to feeding and ceased completely after feeding—usually for about 1 hour. Pulsed sounds of the click-train type, shown to be used for echolocation by two other species of small odontocetes (*1*), accompanied feeding.

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4. The continuous analyses of time versus whistle contour were based on several episodes ranging from 15 minutes to 2 hours in duration. Recorded time (real time) was expanded by reduction of the tape speed to either ⅛ or 1/16 the recorded speed, depending on complexity of the vocal activity. Durations of whistles and intervals between them were then measured with a stopwatch and reconverted to real time. Contour analyses were done by ear at ⅛ real time and periodically checked by sound spectrograms. Whistle durations are averages based on a random sample of 40 of each of the five types of whistle.
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Enforcing Insecticide-Content Water Quality Standards

In his recent article (*1*), Nicholson proposed the establishment of (i) "minimum detectable limits for selected chlorinated hydrocarbon insecticides" and (ii) "10-percent depression in acetylcholinesterase concentration in fish brain" as water quality standards for "point source discharges."

The analytical methods suggested for enforcing these standards are unsuitable. The effective and equitable enforcement of the suggested criteria would be most difficult.

In acetylcholinesterase inhibition studies, values of less than 20-percent inhibition are considered unreliable. As Nicholson reports, the threshold lethal value is 40-percent inhibition. An inhibition range of 20 to 40 percent would be too narrow for monitoring purposes. More important, however, no suitable source of *control* fish brain (0-percent inhibition) is suggested.

As to the chlorinated insecticides, the minimum detectable limits of these compounds are, by definition, at the limit of sensitivity of the method. This screening technique could lead to many false "positive" results, especially from pesticide-manufacturing plants, since the "electron capture" detector is so nonspecific and so highly sensitive. Perhaps Nicholson does not realize how restrictive the proposed standards would be: a plant, for instance, producing 500 kilograms of DDT per 24-hour day and discharging 25,000 liters of waste water per hour, would have to restrict its daily losses of DDT in the waste water to less than 5 milligrams, or one-millionth of 1 percent of its production.

A water quality standard that is more restrictive for benzene hexachloride (BHC) than for endrin can hardly be justified when one considers that endrin is 100 times more toxic to bluegills and 15 times more toxic to mallards (*2*), and much more persistent under all conditions.

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22 November 1967

Many disagreements are a result of failure on the part of one or both parties to fully evaluate the statements or viewpoints of the other. Such seems to be the basis for Cox's objections to my article in *Science* [**158**, 871 (1967)].

He categorically states that the analytical methods I suggest are unsuitable and cites unsupported statistics as proof of his contention. We are able to detect a 10-percent inhibition of brain acetylcholinesterase with 95-percent confidence in a sample of ten fish of the same species and size range whether they come from fresh water or salt. Control fish are taken from a part of the same water system that is being monitored, a part not affected by the suspected source of inhibitor.

So far as false positive results are concerned, when one is monitoring for chlorinated hydrocarbon insecticides, I state again, "The availability of supporting analytical procedures—such as infrared, mass, and nuclear magnetic resonance spectroscopy—for confirmation of questionable identifications should settle any technical argument about the quality of a waste effluent or the reliability of the analytical results reported."

We cannot say with certainty what quantity of any of the named chlorinated hydrocarbon insecticides we can afford to accept in industrial waste effluents. Least of all can such values be based upon acute-toxicity data such as those cited by Cox. Unfortunately, the phenomenon of biological concentration enters the picture and overrides the beneficial effects normally attained by diluting these insecticides in large volumes of receiving water.

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Rotation of Venus

The report by Smith (*1*) on the rotation of Venus may mislead many readers. The title and final remark give the impression that the widely different rotation periods—243 days as against 5 days—determined from radar echoes and ultraviolet photographs, respectively, are "inconsistent," "contradictory," and essentially irreconcilable. Yet the facts presented do not really support the conclusion.

The main purpose of this letter is to dispel doubts about the radar value and to argue briefly the case for consistency and harmony. I consider the radar data first. Observations at seven separate facilities (*2*) in four different countries, at frequencies from 40 to 8000 Mhz (a spread of almost eight octaves) all are consistent with a retrograde rotation period of 243 days. It is true that at only three of these sites, operating at frequencies varying over more than four octaves, were high accuracies achieved: uncertainties in rotation period ranged from less than 1 to about 5 days. But even in the least accurate of the determinations the distinction between a period of the order of 5 days and one of 243 days was quite clear-cut. Furthermore, several independent methods have been used to achieve the radar results. In one, the Doppler spread of time-gated radar echoes is measured over a period of months; the results are unambiguous and hard to fault. In another, the day-to-day movements of rather distinct "features" in the radar echo are followed. Some have been monitored continually for almost 5 years and have been found to recur at the same celestial position at integral multiples of about 243 days, but never at shorter intervals. It is difficult to conceive of any reasonable model consistent with all of these radar data, except for the reflections to be from a surface, at least partially solid, that rotates in a retrograde sense with a period near 243 days. In fact, the spin appears to be locked to the relative orbital motions of Earth and Venus.

Everyone seems to agree that the ultraviolet photographs relate directly only to the conditions near the top of the cloud layers surrounding Venus, *not* to its surface. I am also willing to accept the photographers' conclusion (*1*, references especially) that this part of the atmosphere undergoes a complete rotation in about 5 days. But I see no resultant contradiction or inconsistency. The differential speed near the equator, between the surface and the region monitored by the ultraviolet photographs, is of the order of 100 m/sec. A differential spread of this same order, with the atmosphere moving faster, has been detected repeatedly with Earth satellites and applies to altitudes at least as low as 200 km (*3*). Despite the relatively exalted state of terrestrial meteorology, no one has yet explained satisfactorily this apparently global differential rotation. Given the relatively primitive state of the theory of Venus' atmosphere and the quite different conditions prevailing there (*4*), I cannot see why a high-speed global wind system at the top of the atmosphere should be considered inconceivable. But, in any event, the present lack of understanding of Venusian meteorology is insufficient reason for casting doubt upon the radar determination of the surface rotation rate.

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2. The Goldstone "Venus" radar of the Jet Propulsion Laboratory; the Arecibo Ionospheric Observatory, located in Puerto Rico and operated by Cornell University; the Millstone and Haystack facilities of the M. I. T. Lincoln Laboratory; the University of Manchester radar at Jodrell Bank in Great Britain; the Crimean Radar Tracking Station in the U.S.S.R.; and the Jicamarca Ionospheric Observatory, located near Lima, Peru, and operated jointly by the Instituto Geofisico del Peru and the Institute for Telecommunication Sciences and Aeronomy, ESSA, Boulder, Colorado. [See, for example, I. I. Shapiro, *Science* **157**, 423 (1967) for a list of the more important references.]
3. See, for example, D. G. King-Hele and D. W. Scott in *Space Research VII*, R. L. Smith-Rose, Ed. (North-Holland, Amsterdam, 1967), p. 1192.
4. In addition to the far higher surface temperatures and pressures disclosed by recent space probes, the day on Venus is—if one believes radar results—about 117 times longer than on Earth, presumably creating larger temperature differentials between day and night.

* Operated by Massachusetts Institute of Technology with support from the U.S. Air Force.

13 November 1967