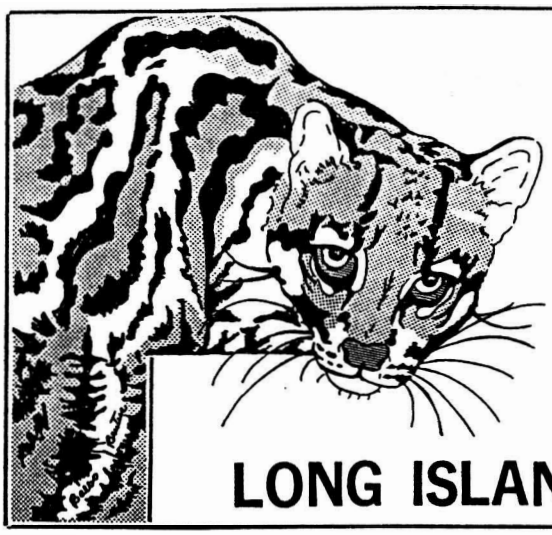

NEWSLETTER

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LONG ISLAND OCELOT CLUB
1454 Fleetwood Drive E
Mobile, Alabama 36605

VOLUME 24 - NUMBER 6
NOVEMBER - DECEMBER 1980

LONG ISLAND OCELOT CLUB

Never a Christmas morning-
Never an old year ends-
But someone thinks of someone;
Old days, Old times,
Old Friends!

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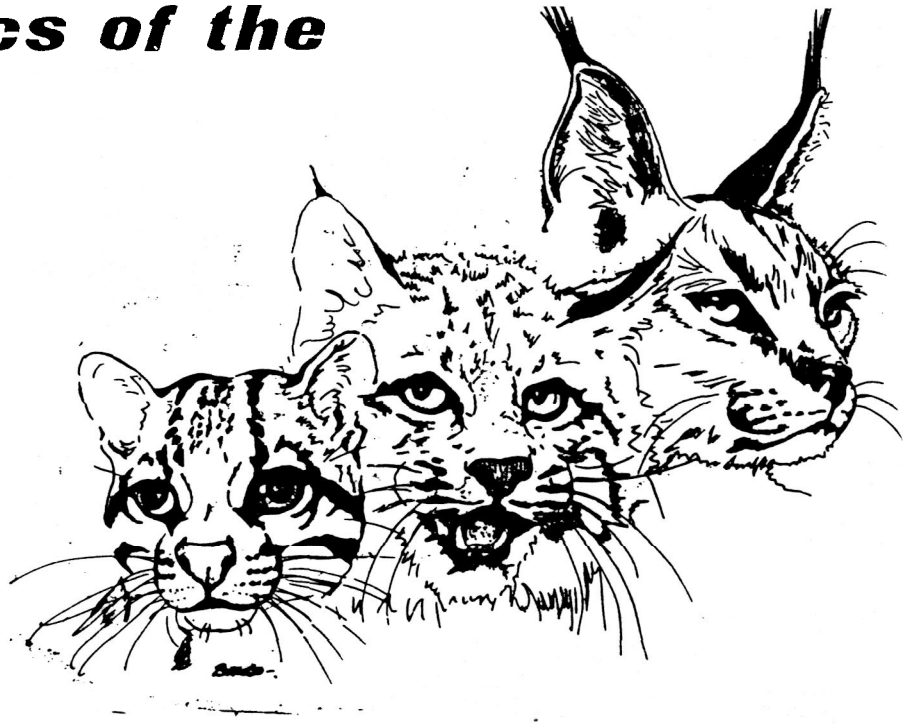
L.I.O.C. NEEDS YOU!

Cytogenetics of the Felidae



By Roy Robinson
Reprinted from THE WORLD'S CATS
Volume 3, No.2, Edited By R.Eaton

Sufficient information has accumulated on the karyotypes of felids that it is now possible to make a general aisal. Out of the 36 species listed by Morris (1965) chromosome content of 28 species has been examined, ilting in the determination of the haploid chromosome er and a workable description of the gross morphology.

The parameters usually studied by karyologists are the haploid number of chromosomes& the position of the centromere within the individual chromosomes. The position of the centromere determines whether the chromosome is depicted as metacentric (centromere positioned in the middle so that the chromosome has two arms of equal length) or acrocentric (centromere at one end so that the chromosome has only one arm). More often, the centromere is not positioned exactly in the middle nor right at the end. These are described as submetacentric and subacrocentric, respectively. The two sorts of chromosomes tend to graduate into one another but, in the main, the classification is convenient. A count of the number of chromosome arms (two for each metacentric or submetacentric and one for each acrocentric or subacrocentric) has led to the concept of the "fundamental number: a statistic which has featured in many studies but whose significance is too easily over-rated.

It is possible to rank the chomosomes in terms of decreasing size, generally, as large, medium and small. However, there is usually a gradual size transition and overlapping of individual chromosomes from cell to cell. For this reason, some researchers are reluctant to do more than arrange the chromosomes in groups. In this respect, the felid karyotype is usually shown as possessing six groups of essentially similar elements. On the other hand, it is possible to distinguish exceptionally large chromosomes or those with special features. The very small chromosomes are often difficult to consistently classify as metacentrics or acrocentrics.

KARYOTYPES

Because of the animal's ready availability the karyotype of the domestic cat has been repeatedly investigated and e is now an extensive bibliography. The present consus is that the cat has five large to medium and three metacentric chromosomes, eight large to medium subcentric chromosomes and two small acrocentric or subacrocentric chromosomes. The X sex chromosome is a medium sized metacentric and the Y is a small submetacentric or subacrocentric. The putative wild ancestors of the domestic cat either F. silvestris or F. libyca, probably the latter) have not been analyzed in detail as yet but appear to have an identical karyotype to the domestic cat (Table 1).

It is worthwhile to consider the chromosomes of the domestic cat in more detail, partly because the species has been so thoroughly studied and partly because the karyotype is remarkably similar to the majority of wild species so far examined.

GROUP	DESCRIPTION	NUMBER
A	Large submetacentric (centric region is slightly off center)	3
B	Large submetacentric (centric reion more off center)	4
C	Large metacentric	2
D	Small submetacentric	4
E	Small metacentric	3
F	Small acrocentric	2
X	Medium submetacentric	1
Y	Small metacentric	1

The above karyotype is shown diagramatically by Figure 1, based upon published presentations. The karyotype has 19 chromosomes and 36 chromosome arms. Now, the interesting aspect is that this karyotype is the most frequent among those species investigated (19 species out of the 29 listed in Table 1) The next most common karyotype (4 species) has 19 chromosomes but 37 arms. There is a loss of one of the small acrocentrics but the gain of a small metacentric as a result of perimetric inversion within the former (Figure 2).

In the case of the jaguarondi, both of the small acrocentrics seem to have undergone transformation to either metacentrics or submetacentrics. The species has 19 chromosomes but 38 arms (cf. Figure 3 with Figures 1 and 2) The published photomicrographs (Wurster 1969) indicate the gain of a large or medium body, hence some mechanism

er than or in addition to simple inversion may be involved. On the other hand, arguments based soley on relative size are open to dispute and at this point must remain open.

If 19 chromosomes are regarded as typical for the felids, there are five species which have merely 19, an intriguing situation. In three of these (F. colocolo, goeffroyi and tigrina), all of the 18 chromosomes are metacentric (36 arms), as if the two small acrocentrics had undergone centromeric fusion into a single metacentric (Figure 4) The total chromosome content is decreased by one autosome but with no loss of genetic material.

In the case of the other two species (F. pardalis and wiedi), one of the small acrocentrics has disappeared but with no accompanying increase in the number of metacentrics (18 chromosomes, 35 arms, see Figure 5). It is possible that the acrocentirc has been lost during evolution but it is more probable that the missing chromosome has fused with one of the metacentrics or submetacentrics. This is shown by the apparent possession by these two species of an additional large metacentric chromosome in group C (Figures 1 & 5). Thus, five distinctive karyotypes may be distinguished. Provisionally, karyotype 1 (19 chromosome, 35 arms) may be regarded as the primitive form, from which theothers are probably derived. The four differing karyotypes are designated as karyotypes 2 through 5 as shown in Table 2.

TABLE 2 - Classification of species according to felid karyotype

KARYOTYPE	SPECIES	NO.OF SPECIES
1 : 19C, 36A	F. auratus, canadensis, caracal chaus, domesticus, libyca, margarita nigripes, ornata, rufus, serval, silvestris, temmincki, N. nebulosa, P. leo, onca, pardus, tigris, uncia.	19
2 : 19C, 37A	A.jubatus, F. bengalensis, concolor, viverrina	4
3 : 19C, 38A	F. yagouaroundi	1
4 : 18C 36A	F. colocolo, geoffroy, tigrina	3
5 : 18C, 35A	F. pardalis, wiedi	2

C = no. of chromosome A = No. of arms

Although it is proper to emphasize the differences between the five felid karyotypes, it is just important to appreciate the similarities. In fact, the similarities may out-weigh the dissimilarities because, at the present level of analysis, the differences revolve around the apparent redistribution of the genetic material carried by the two smallest autosomes. Most of the main groups of chromosomes appear identical in gross morphology for every species. Only one chromosome has a distinguishing feature. One of the small metaCentrics (E1) is rather conspicuously satellited. This chromosome is present in every karyotype examined and the inferences may be drawn that many, if not most, of the other chromosomes are corresponding homologues. Wurster and Benirschke (1968) termed this conspicuous element the "carnivore" chromosome because a comparable satellited chromosome may be discerned in karyotypes of not merely the felids but in species belonging to related families of carnivora.

The sex chromosomes are similar for each species. In general, the X is a medium sized sumetacentric and the Y is a small submetacentric. This similarity cannot be used as an argument for parallel comparability of the autosomes since it probably represents the conservation of form and function of the sex chromosomes during evolution. If ohno's (1967) thesis is correct, the X chromosome has survived relatively intact, while the activity of the Y has declined until it is now function was to determine maleness, despite considerable changes among the autosomes.

It is noteworthy that the five species with the 18 chromosome karyotype all belong to Central and South America. It is tempting to presume that the process which caused the reduction in number are related to this fact. Even the Jaguarundi, which has also undergone marked changes of karyotype, is found in this same region. The felids are assumed to have initially evolved in Europe and Asia reaching North America via the Bering Straits and eventually migrating southwards. The number of individuals crossing the Straits must have been relatively few at any one time. Thus, the situation could have been a combination of "founders' effect" and the "advancing wave" of a colonizing species spreading into a vast new territory. Two "bottle necks" may be envisaged, one at the Bering Straits and the other of the land bridge comprising Central America. The process may, therefore, have occurred twice.

**Editor's note: As noted in the article last issue by Pat Warren, recent findings of the remains of a prehistoric cheetah in Colorado may have changed some of these findings.

Selection pressures would undoubtedly be different in the various continents and may have undergone periods of less intensity. The situation was ripe for the occurrence of diversity as a result of the advancing wave breaking up into isolated and probably not too large populations. Isolation is a prerequisite for the evolution of unique karyo types and of speciation. The relaxation of selection pressures due to the exploitation of new habitats could have played an equally fundamental role. Once the new territory has been fully saturated, the selection pressures will intensify and there will be a sorting out of adaptable karyotypes. The 18 chromosome and the jaguarundi karyotypes may have differentiated during this period and survived to the present day. There is no compelling reason to suppose that these more recently evolved karyotypes are necessarily superior to the original karyotypes from which they evolved, although they may be.

The evolution of the 19 chromosome, 37 arm aryotype for the "old world" cheetah, fishing cat and leopard cat is less easily surmised. The cheetah occurs in Africa and the Middle East while the fishing cat and leopard cat occur in Asia. The latter two species are sympatric. It may be that the large stretches of water which produced the Mediterranean Sea and the Himalyayan mountain range acted as barriers for some of the southern early felid populations to become isolates, thus providing opportunity for the karyotype to become established. Presumably, this event occurred in a progenitor of the three species. Further more since the karyotype is also shown by the puma of North and South America, it would seem that the progenitor was a contributor towards the felids of the New World. Of course, one could opine that the event occurred in the New World and that the karyotype found its way back into the Old World; or that similar events occurred in both of the super-continents.

The wide occurrence of the 19 chromosome, 36 arm karyotype would imply that this was the original or primitive form, or, alternatively, the most successful of the ancient felid karyotypes. If the other karyotypes are derivative, there is no reason to assume that the changes which gave rise to the new karyotypes are other than independent and unique events. An exception could be made for the jaguarundi 19 chromosome, 38 arm karyotype which appears to have come into being by pericentric inversion of the two acrocentrics. Rather than postulate three independent inversions, it may be that the jaguarundi karyotype arose from an earlier 19 chromosome, 37 arm karyotype which ultimately produced the puma. On this basis, it is only necessary to assume two independent occurrences of inversion.

It would seem that further insight into the differences and similarities of felid karyotypes must wait upon the application of techniques which bring out the banding patterns of individual chromosomes. Careful analysis have revealed that each chromosome of a species (e.g., mouse, rat, Chinese hamster) can be distinguished by a means of specific differential staining or fluorescent pattern. This represents an outstanding advance over previous methods for chromosome identification. A useful bibliography on the literature dealing with the various techniques which can be employed has been compiled by Nilsson (1973).

The house mouse (Mus musculus) has 20 acrocentric chromosome which differ in size but, with rare exceptions, could be individually identified only with great difficulty. With the event of the new techniques, for revealing the inherent banding patters, this problem has been resolved. Successful

a[illegible]ation of the techniques did not end here. The allied sp[illegible]es of tobacco mouse differs from the house mouse in coat color and skull shape but hybridizes readily, even if the hybrids are subfertile.

TABLE 1. Karyological data on the Felidae

SPECIES	Haploid Number	Metacentric & Submetacentric Chromosomes	Acrocentric & Submetacentric Chromosomes	No. of Arms
OLD WORLD SPECIES				
Acinonyx jubatus (Cheetah)	19	18	1	37
Felis auratus (African Golden Cat)	19	17	2	36
Felis bengalensis (leopard cat)	19	18	1	37
Felis caracul (caracal lynx)	17	17	2	36
Felis Chaus (jungle cat)				
Felis Domesticus (domestic cat)	19	17	2	36
Felis libyca (African wild cat)	19	17	2	36
Felis margarita ([illegible] cat)	19	17	2	36
Felis nigripes ([illegible]-footed cat)	19	17	2	36
Felis ornata (Indian desert cat)	19	17	2	36
Felis serval (serval)	19	17	2	36
Felis silvestris (European wild cat)	19	17	2	36
Felis temminicki (golden cat)	19	17	2	36
Neofelis nebulosa (clouded leopard)	19	17	2	36
Panthera leo (lion)	19	17	2	36
Panthera onca (jaguar)	19	17	2	36
Panthera pardus (leopard)	19	17	2	36
Panthera tigris (tiger)	19	17	2	36
Panthera uncia (snow leopard)	19	17	2	36
NEW WORLD SPECIES				
Felis canadensis (Canadian lynx)	19	17	2	36
F[illegible] colocolo ([illegible]as cat)	18	18	0	37
F[illegible] concolor (cougar)	19	18	0	37
Felis geoffroyi (Geoffroy's cat)	18	18	0	36
Felis pardalis (ocelot)	18	17	1	35
Felis rufus (bobcat)	19	17	2	36
Felis tigrina (tiger cat)	18	18	0	36
Felis viverina (fishing cat)	19	18	1	37
Felis weidi (margay)	18	17	1	35
Felis yagouaroundi (jaguarondi)	19	19	0	38

References: Hsu et al.(1963), Hsu & Rearden (1965), Wuster & Benirschke (1968), Wurster (1969), Jotterland (1971) and Wurster-Hill (1973)

Most intterestingly, while the house mouse has 20 acrocentric chromosomes, the tobacco mouse has seven metacentric and six acrocentric chromosomes. It may be speculated that the seven poschiavinus metacentrics had originated from 14 musculus acrocentrics by successive fusions. Confirmation was provided by examination of the banding patterns of the chromosomes of the two species. It was possible to identify the individual chromosomes and to indicate which of the musculus acrocentrics had fused to produce the various poschiavinus metacentrics.

The positive results with the mouse chromosomes gives confidence that it should be possible to obtain similar results by meticulous examination of felid chromosomes. There are two problems to be tackled. The first is to establish if the missing acrocentrics have fused to produce metacentrics and/or have fused with existing metacentrics. The two tasks are interrelated since it is probable that the other structural rearrangements of chromatid material have occurred between the chromosomes. If felid chromosomes are as homologous as their gross morphology would imply, this study should yeild interesting information. Potentially, it could provide greater insight into the affinities of the various species and of their probable evolutionary connections.

HYBRIDIZATION

Additional evidence for the basic similarity of the felid karyotypes is indicated by the comparative ease by which hybrids may be obtained. By dint of different reproductive behavior, geography, hybridization in the wild is practically ruled out. The situation is otherwise in zoos where individuals of different species can be familized and the normal sexual behavior subtly modified. The hybrids from the larger species have attractred the most attention; witness, the interest taken in producing ligers (male lion x female tiger) tigons (male tiger x female lion) and leopons (lion x leopard). Less well known hybrids are those of leopard with jaguar, puma and tiger, lion with jagauar and jaguar with puma (se: Gray, 1972 for a review). In most cases, the fertility of the hybrids has not been studied in detail, but, in so far as one may generalize, the males are nearly always sterile while the females may be feebly fertile.

A similar picture has emerged for the smaller species. Hybrids have been procured between the domestic cat and the bobcat, black-footed cat, leopard cat and tiger cat. The most interesting hybrid is that between the domestic and tiger cat (Felis tigrina - Leyhausen & Falkena 1966) for the former has the type 1, 19 chromosome karyotype and the latter, the type 3, 18 chromosome karyotype. Bespite the differences, seven hybrids were produced. Of these, three were still-born (unsexed) while the four

vivors where females. All four females were sterile; seems to be the case for all of these hybrids although ...is aspect has not been critically assessed.

Hybrids between the domestic cat and the European wild cat (F. silvestris) have been obtained repeatedly. These offspring are fertile. Hybrids of the domestic and the steppe cat (F. caudata) are reported to be fertile. Offspring from crosses of F. silvestris and libyca have been produced but little information seems to be available on their fertility. A cross between the domestic cat and jungle cat has produced viable hybrids and the females are fertile (Jackson & Jackson 1967). The fertility of hybrids between the domestic cat and either European or African wildcats is not surprising since the latter in particular is thought to be the ancestor of the domestic. F. silvestris and libyca are probably merely forms of the same species comples (Weigl, 1961). On this showing, F. chaus would appear to be a closely related species.

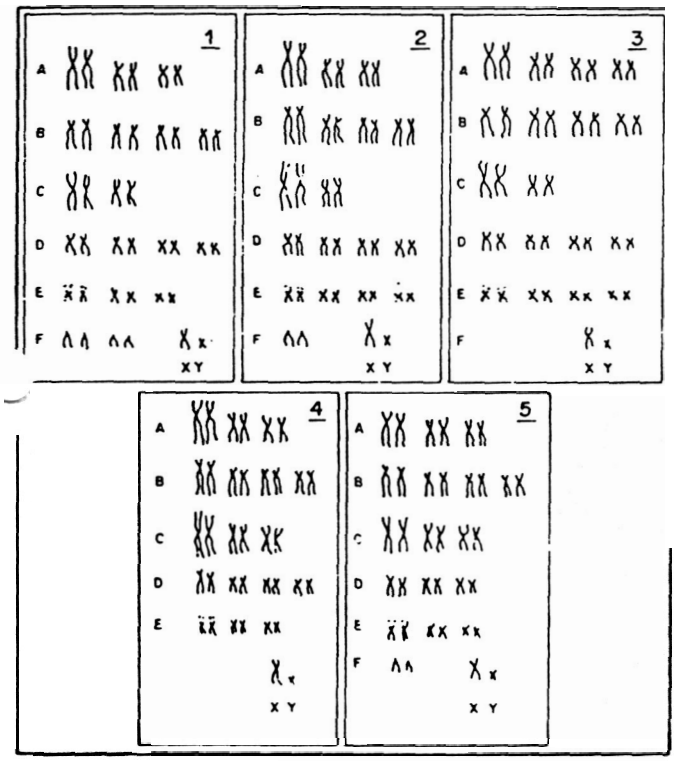


Figure 1 - 5

The five karyotypes of Felidae: 1. domestic cat; 2. fishing cat; 3. jaguarondi: 4. pampas cat; 5. ocelot.

The production of viable hybrids from crosses of so many of the species can only follow from the similarity of karyotype. Evidently the chromosomes are compatible enough to support normal development but not enough for the completion of normal spermatogenesis. It is possible to make little or much of the sterility but the inference is that the differences exist between the chromosomes disruptive to normal meiosis. Successful meiotic pairing is a sensitive indicator of chromosome homology and its failure, even for hybrids between species possessing the same 19 chromosome, 36 arm karyotype, is indicative of either genetic or chromosomal differences which are undetectable at the present level of karyological analysis.

ONOMY

e the karyotypic observations any relevance for taxonomy? The karyotype is fundamental in the creation of species, but, in the past, consideration of the karyotype has played a minor role in the recognition of valid species and genera; due in part to the lack of reliable information but the outlook in this field is changing.

The remarkable similarity of karyotype for all of the felids would lend scant support to those who would multiply the number of genera. It may be argued that the existance of five distinguishable karyotypes is sufficient reason for the rather embrasive genus Felis to be subdivided, especially when the argument can be supported by other consistent evidence. For example, the last six species of Table 2 could be treated as three special groups, possibly worthy of generic status, by virtue of distinctive karyotypes and geographical location.

On the other hand, while the nomenclature in this paper has followed that of Morris (1965) it may be noted that the karyotypic classification of Table 2 gives no support to placing nebulosa in a distinct genus - Neofelis (rather than Felis) nor, for that matter, to separation of the species leo, onca, pardus, uncia as a genus Panthera. Perhaps most taxonomists would regard this latter opinion as going too far.

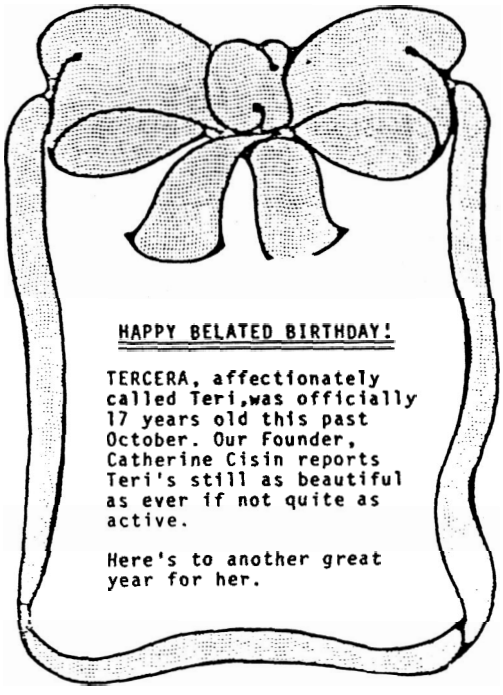
SUMMARY

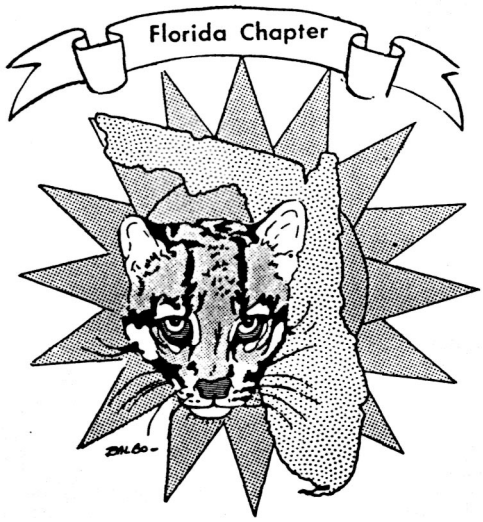
The published material on the chromosome morphology of felid species is reviewed. Five distinctive karyotypes may be recognized. One particular karyotype occurs in 19 of the 29 species so far karyologically examined. This karyotype either represents the most successfully adapted for the felid mode of existance or is the primitive form for the family. The geographical location of the other 10 species with differing karyotypes (on the outer fringes of probable spread of ancient felid migration) implies that the mor frequently occurring karyotype is the ancestral form. If so, the trend is towards a reduction in chromosome number. It is speculated that the new karyotypes arose as chromosomal rearrangements (nversion, fusion) as a consequence of small populations of felids becoming isolated in Africa, India and the American continents during the early evolution of the felid family. To fix a time scale, this isolation and subsequent speciation probably occurred during the Pliocene Epoch

1981 CALENDAR

The San Diego Zoo has just released its 1981 zoo calendar This year features the exotic cats. Photos of the Snow Leopard, Golden Cat,, Lion, Cheetah, Serval, Tiger, Leopard and an adorable Lynx kitten Beautify each month.

To order send $3.50 to Zoo Calendar, P.O.Box 551, San Diego, CA 92112





Have you heard of Crystal River, Florida? Well, you might if you know about nuclear power plants, because one of them is located here. But on November 9th, Crystal River was best known as the home of Art and Gertrude Freeman who played host to the most recent meeting of the Florida Chapter of LIOC.

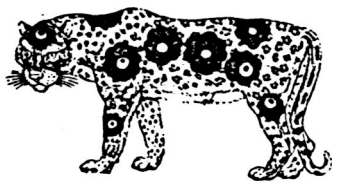
Crystal River is a very pretty part of western Florida with many rivers and canals as the name implies. A brief business meeting was held to discuss the 1981 convention and the need to raise money prior to that event for depo[illegible]s and incidentals. Suggestions were taken on how to [illegible]plish this and we invite other Branches to partici[illegible]in the raffle and sale table.

A p[illegible].c style lunch of ham and hot dogs preceeded a slide show on endangered animals. In addition, we saw slides on cranes and heard of their status in the wild.

The highlight of the meeting is the cats that visit and this meeting was not exception. How about a 5 month old black jaguar that wants (demands?) to sit on your lap. He was very friendly but BIG; Also a little baby jag and a margay named Sundae. The two jags were courtesy of Delores Newman who raises some of the animals for Robert Baudy of Savage Kingdom. Delores had someone to talk to in the form of Gladys Lewis who also helps Baudy out and has lep-jags of her own. A real treat was seing Charles, Sadie and Michael Douglas at this meeting. Jamie Wheatly and his Aunt & Uncle, BeeJay Lester and Jim Scott drove all the way from Hollywood, Fl. a six hr drive each way, and Barbara Bond came up from Tampa with Anne Davis. Michael Foisy motercycled to the meeting so he didn't bring his cat. James and daughter Candi Fey helped Delores with watching and walking the jags.

The next meeting will be in South Fla and the subject will again be plans for Convention.

Submitted by
Danny Treanor
President



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Fre[illegible] Complete Works of Saki by H.H. Munro

Con[illegible] a child, a puppy and a kitten with sudden danger; the chi[illegible]ll turn instictively for more assistance, the puppy will grovel in abject submission but the kitten will brace its tiny body for a frantic resistance

* * * * * * *

Goodwill to Wildlife 1981

News from BeeJay Lester's Margay Menagerie is sad and glad. SLIM (10 year plus silver & black male) died of chronic interstitial nephritis after a 5 week battle and much medication. His mate, "ALFIE" a 13 year, 8 lb. female, died of post operative complications after a 1 lb fibrosarcoma was removed. Previously another pair had died while on breeding loan.

The "Menagerie" now consists of 12 year GIGOLO (my jungle jewel) who is feeling his years but is still the love of my life, and a 3 year old captive born female "SABRINA". She is currently housed and compatible with a young borrowed male They mated during her last estrus cycle (3 weeks ago) but as yet there are no signs of conception.

Wish us luck in 1981! We all wish our fine furred friends and their owners the same

NO END TO IT

There are reputedly only 300 of the snow leopard left in Mongolia but for $50,000 in US currency Mongolia's communist government will guarantee that you bag one. Some bargain for big game hunters?

The Mongolian government is not a signatory to the International Convention. Excursions to hunt these rare cats are being arranged by two outfitters in the U.S. and Germany and although westerners aren't usually welcome in this communist country, a big-game hunter with $50,000 is welcomed with a red carpet.

And they have been coming in droves, especially since Iran and Afghanistan have been closed to hunters. Those two countries before their respective revolutions once boasted some of the best bighorn sheep hunting in the world. Now Mongolia is virtually the only place that trophy can be had - for only $16,000.

As recently as 1970 Mongolia had banned hunting. There are no figures available for the number of snow leopard that hunters are allowed to take. In 1966 the last year for which any reliable figures are available, there were believed to be only 300 leopards left in Mongolia. On Mongolian official attributed the program to the country's dire need for hard currency and foreign exchange. Because almost all of its trade is with the Soviet Union, it has little means of getting hard currency.

One way is tourism and for that reason Mongolia recently has been tryying to foster that industry although it is hampered by lack of hotels and tourist attractions. With hunting and official said, "we get large amounts of currency with very little investment. The hunters stay during most of their trip in tents and leave after bagging their trophies. Two American hunters who were encountered by chance said they expected no trouble in taking their trophies home despite the U.S. ban on such.

PAINLESS DENTISTRY

Dentists at the Audubon Zoo in New Orleans, La. were taking no chances with a patient named Scotty. Scotty was completely sedated and even when unconscious was strapped to an operating table so he couldn't move so much as a finger....but then who wants to take chances with root canal surgery on a 310 pound gorilla?

BIGFOOT MADE IT

Better make one of those "I survived Mt.St. Helens T-shirts in an extra-extra large size. A bigfoot track has been found in the ash-shrouded forest around the volcano.

A U.S. Forest Service guard stationed in Packwood, Wa. reported she found an 18 by 8 inch ape-like track and photagraphed it in late July. The trail near where the track was found has been closed since the eruption. Other sitings of tracks have been reported near Sandy Ore. since the eruption.

LOVE MAKES PETS HEALTHIER

We've found that even on high cholesterol diets, animals treated with love and affection came down with only 1/3 to 1/2 of the hear disease that other animals suffered" says Dr. J.F. Cornhill, a researcher at the Ohio State University.

The implications of the study are more far reaching than may appear observed Dr. Michael Fox of the Institute for the Study of Animal Prolems in Washington, D.C. "It puts a big question mark on the validity of a lot of animal research. It could mean that a lot of lab studies on animals aren't worth a damn." Animals kept in cages and deprived of lots of personal contact and affection just will not do well and won't be in good health.

DOG BILL PROPOSED

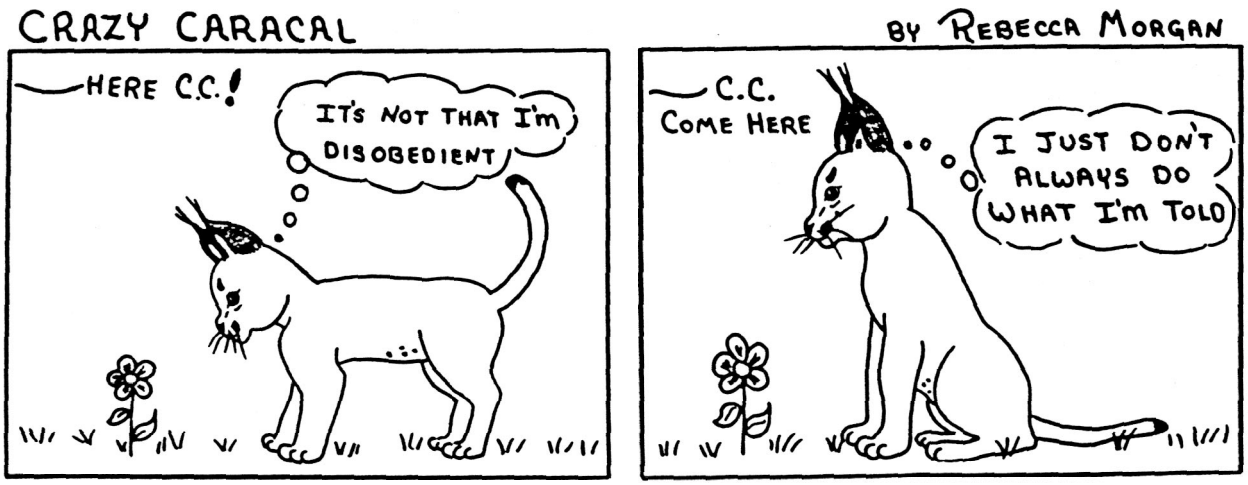
Killing a cat or dog with the intention of eating it would be illegal in California under a bill recently introduced in the Legislature an AP article reports.

State Sen. Garcia said he introduced the bill because of a recent incident where dogs were being trapped by S.E. Asia refugees who consider dogs delicacies. The penalty would be up to six months in jail and a $500 fine.

HERO CAT

The first hero cat of the Decade award has been posthumously awarded to Rhubarb, a Siamese cat that for 17 years was the seeing-eye companion of a San Diego resident. Rhubarb, who could do anything a guide dog does, including seeing his blind mistres across the street, died in April.

RARE RED WOLF ON INCREASE

The red wolf is extinct in the wild, however there are now 32 adults in captivity all in the N.W. This year's crop of pups number 28 at Dale Petersen's compound in Tacoma and four at the zoo in that same city. The red wolf is a native of Texas, Louisiana and the SE US.

In 1973 the Fish & Wildlife Service trapped what few remaining "wolves" there could be found. However, due to extensive inbreeding with domestic dogs and coyotes, there were few that matched to skulls in museums. Those that did were placed in the breeding program in Tacoma. Annually, when pups are born all pups are of identical size and color if they are true red wolves. Those that don't confirm to the majority of the litter are considered to have parents other than the red wolf, and are eliminated from the breeding program.