LA-UR-15-22045
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Title:	Supplementary Feeding, Plumage Documentation and Early Season Prey of Peregrine Falcons at the New Mexico Alpha Eyrie
Author(s):	Ponton, David A.
Intended for:	Documenting historical work
Issued:	2015-03-20

SUPPLEMENTARY FEEDING, PLUMAGE DOCUMENTATION AND EARLY SEASON PREY OF PEREGRINE FALCONS AT THE NEW MEXICO ALPHA EYRIE

This report is a re-publication of Los Alamos National Laboratory memo report WX-1-84-55 originally published February 24, 1984 for a project done in 1983 at the peregrine falcon eyrie in Pueblo Canyon that is now designated R-30 for purposes of statewide surveys.

DAVID A. PONTON
LOS ALAMOS NATIONAL LABORATORY
GROUP W-4
PO BOX 1663
LOS ALAMOS, NEW MEXICO 87545

ABSTRACT

A review of what is known about avian physiology and the biological effects of DDE suggests that some benefit to peregrine falcon egg condition could be attained by artificially feeding DDE free prey to the female from the time of her arrival on the nesting grounds until completion of egg laying; the magnitude of potential benefit is unknown. Sporadic efforts in the past demonstrated the need for precision methods of prey delivery. Two methods were developed and tried; providing dead prey items by dropping them in a day perch, and delivery of live prey by remotely controlled release from compartments positioned at the top of the cliff occupied by the falcons.

Maintaining quail in the day perch for 21 days resulted in at least one and probably two meals for the female peregrine. Of 16 live birds released (mostly pigeons) 13 were pursued and three caught. Blinding the pigeons with tape proved to be necessary to enable capture. Also, some reluctance of the male peregrine to attack pigeons was observed, and problems with equipment, visibility, and the proximity of the falcons to the release box were encountered. Manpower was the most significant resource requirement. Baiting of great-horned owls, possibly leading to owl attack on the falcons, is judged to be the largest detrimental effect of supplemental feeding. It is recommended that supplemental feeding be reserved for falcons or eyries where complete reproductive failure is expected.

Plumage documentation photography was successfully conducted by a remotely controlled camera as an aid to identification of individual falcons. American robin, red-winged blackbird, starling, white-throated swift, bluebird, and mourning dove were among natural prey consumed by the peregrines before completion of egg laying. All activities in close proximity to the cliff were conducted at night to preclude direct disturbance of the falcons.

BACKGROUND

The major cause of the decline of the peregrine falcon (Falco peregrinus) is reproductive failure caused by chlorinated hydrocarbons (e.g. DDT) and their metabolites (e.g. DDE). Such reproductive failure is characterized by reduced viability of eggs through thinner shells (Ratcliffe, 1980), reduced porosity of shells (Newton, 1979), and embryo mortality from a direct toxic effect (Newton, 1979).

Termination of the use of DDT in the United States did not end the contamination of peregrine falcons with this compound, because both the falcons and their prey migrate out of the country to areas where DDT is still used. Also, other chlorinated hydrocarbons could be involved. This paper will only address DDE, the most relevant metabolite of DDT.

More food than normal is consumed by female raptors prior to egg laying. Newton (1979) argues that this not only enables the female to produce eggs, but also allows her to accumulate body reserves for use in the incubation and nestling periods. Indeed, he states that female European kestrels, sparrowhawks, vultures, and tawny owls were still heavier than normal after completing their clutch. While both fat and protein are being stored prior to egg laying, the fat is a large reservoir for DDE (Lincer et al., 1970), which can be expected to be metabolized whenever the fat is metabolized.

The level of contamination of the fat is directly proportional to the level in the diet, as would be expected with various drugs. DDE is not excreted efficiently, so it reaches a relatively high concentration before equilibrium occurs.

The increase in DDE contamination with diet is illustrated dramatically by the increase in blood contamination levels after peregrines spent their first winter south of the border. Peregrines from northern regions, on their first fall migration south, had blood plasma levels of DDE of 0.05 ppm wet weight; those on their first northerly migration, in the spring, had 0.60 ppm, a 12 fold increase (Henny, et al., 1982). If the dietary contamination were to end abruptly, the level in the fat would decrease slowly. This rate of decrease is unknown in the peregrine falcon, but in pigeons, it has been shown to have a half-life of 8.3 months (Bailey, et al., 1969). No significant reduction in blood levels of DDE of peregrines spending a season on northern breeding grounds was detected in a comparison of spring and fall migrants (Henny, et al., 1982).

The most familiar and best understood effect of DDE on reproducing birds is that of eggshell thinning. It has been shown that DDE affects shell gland function, leaving other bodily functions involving calcium undisturbed (Peakall, et al., 1975). Specifically, DDE has been shown to inhibit Ca ATPase (Miller, et al., 1976), which is the enzyme responsible for transferring calcium across the membrane of the shell gland to the eggshell. Presumably, the DDE level in the blood supply to the shell gland determines the degree of inhibition of calcium transport. The level of DDE in the blood at the time of eggshell formation can be expected to be related to (simultaneously) the general contamination level of the bird, the amount of DDE contaminated lipids that are being metabolized for the formation of eggs subsequent to that for which the shell is being formed, and the level of DDE in food that is being digested. (The latter two conditions suggest that increased variation between eggshell thickness of eggs within a clutch could be expected in association with DDE. While considerable variation occurs among eggs within clutches, the connection has not been demonstrated.)

THEORETICAL POTENTIAL

The ultimate objective of artificial feeding of peregrine falcons would be to minimize the effects of DDE on reproduction. Theoretical mechanisms include 1) reducing direct contribution of contamination from food intake, 2) reducing the level of contamination by allowing excretion to occur, 3) insuring that new fat accumulations are not contaminated, 4) maximizing stored fat by ensuring food availability in periods of reduced hunting opportunity, such as inclement weather.

The only time during the peregrine's annual cycle that offers any potential benefit from artificial feeding is the period from arrival on the breeding grounds to laying of the last egg. This is because the peregrine is not available for manipulation during the winter, and any DDE reduction that might be accomplished between egg laying and fall migration would be reversed over the following winter, as demonstrated by the work cited earlier. Also, a feeding program of that duration would require huge resources.

An estimate of the potential reduction of fat contamination (ratio of the amount of contaminated fat at arrival to total fat at the start of egg laying) cannot be made because these levels are unknown for peregrine falcons. An assumption of zero fat at arrival is not reasonable, because peregrine falcons feed during migration, sustaining their condition. Also, a bird with zero fat reserves would be debilitated by the relocation of contaminants, unable to tolerate harsh spring weather, and generally unfit to breed. Such birds are not encountered on breeding territories.

Using the DDE half-life of 8.3 months cited for pigeons means a bird with no DDE in its diet for one month (a typical interval from arrival to egg laying) will reduce its contamination level eight percent by excretion. By itself, this amount of reduction would be negligible.

While peregrines are efficient hunters and maintain caches of excess food (T. Johnson, pers. comm.), periods of inclement weather might prevent hunting. If cached food was exhausted, the female would draw down body reserves, rather than build them up. While conditions like these do not occur regularly, supplementary feeding during these times would continue the development of the female's condition, and maximize the fat and the ratio of total fat to DDE burden.

Finally, assuming there exists a direct effect from the digestion of a DDE contaminated food item on the formation of an individual eggshell, supplementary feeding will eliminate the effect.

OTHER WORK

While many other species of raptors have been artificially fed, little work has been reported on the peregrine falcon. A widowed female in California was fed live pigeons or other species released from a blind, and successfully fledged young (Cal .Dept. of Fish & Game, 1977). Nine hundred inexperienced pigeons were released at four coastal eyries in California in hope of reducing the peregrines utilization of shore birds and other heavily contaminated species. Additionally, cached items were swapped at one eyrie, though there seemed to be little utilization of the swaps (Brain Walton, pers. comm.).

Scattered releases of pigeons were made at the New Mexico alpha eyrie by this author from

1971 to 1976. Releases of unhampered pigeons in small groups from the canyon floor on 20 occasions resulted in 8 pursuits, but no captures. A single blinded pigeon released from the top of the cliff was taken by the adult female.

The above work suggested that a precision method of offering supplementary food was necessary if anything near 100% supplemental feeding was ever to be realized.

OBJECTIVE

The objective of this research project was to develop, test, and demonstrate practical and effective methods of delivery of prey to wild nesting peregrine falcons to enable the assessment of the management potential of supplementary feeding. Field work was to be consistent with a policy of non-disturbance that has been adopted by agencies and individuals concerned with the welfare of peregrine falcons in New Mexico. Co-objectives of identifying early season prey, and photographically documenting plumage characteristics of individual peregrine falcons were adopted as they are related to the primary objective and are consistent with field activities used to carry it out.

LOCATION

The New Mexico Alpha site possesses several unique characteristics that make it an excellent location for this demonstration project. It is "close to town," which keeps down the travel requirements; the cliff is accessible from above and below, and an accessible viewpoint exists for a telescope capable of viewing the interiors of caves on the cliff. Portions of the land utilized by the falcons is within the Los Alamos National Environmental Research Park, which exists for the purpose of “outdoor” experimentation.

METHODS - Cache Cave Stocking

The peregrine's usual cache caves are accessible only by rappelling, exist in large number, and are not used consistently, so thoughts of stocking these at night were abandoned. Instead, a hand held crane that was developed in 1982 was used at night to drop frozen quail carcasses into the cave behind a day perch. Because that particular day perch is used frequently by the falcons, they had the opportunity to utilize the prey *ad libitum*. The falcons were observed from below during the day to determine reactions. Utilization was determined by viewing the interior of the cave with a telescope from the opposite rim.

METHODS - Live Release

A three compartment box, each compartment having a trap door floor, was suspended near the top of a sheer portion of the cliff. At night, each compartment was loaded with a live bird. The birds were handicapped to varying degrees. In the early morning, birds were released by remote control, one at a time, when a falcon was judged to be in an advantageous position. Pursuit and capture were observed visually, and the efficacy of various conditions, bird sizes, and handicaps were judged.

To avoid introducing disease to the peregrines, the mouths and throats of the pigeons were inspected just before release to confirm the absence of Trichamoniasis lesions. Also, prophylaxis for worms was done by periodic treatment of the pigeons' drinking water with soluble

Piperazine. Birds were not used for at least three days after treatment to allow time for the drug to clear their bodies, even though no adverse effects would be expected from the falcons ingesting a freshly treated bird.

METHODS - Plumage Photography

The camera in a plastic enclosure was positioned on a boulder eight meters from the falcons' favorite tree (snag at the top of the cliff) and covered with cloth dipped in paint for concealment (mainly from vandals). Focusing was achieved at night by use of a white painted fishing pole illuminated by a penlight taped to the shaft. The pole was hung vertically from the branch of interest, providing a bright vertical line for alignment in a split prism rangefinder-type viewing screen. The tree was observed from the bottom of the canyon during the day, and the camera was tripped by remote control when falcons landed in the field of view.

METHODS - Early Season Prey Identification

Prey in the possession of the falcons was observed with the aid of a high power telescope. Feathers plucked from prey were collected below the favorite tree and at other places. When possible, all feathers were removed to enable the temporal separation of individual prey items. Feathers were sent to the New Mexico Department of Game and Fish for identification. In one case, the remote control camera was used to document a prey item in the possession of a falcon.

A typical field episode consisted of driving to the top of the mesa, scrambling down to the shelf (large stratification running the full length of the cliff about 10 meters wide and 10 meters below the top of the mesa), loading pigeons into the release compartments, changing film in the camera, searching for prey remains below the peregrines' favorite tree, dropping quail carcasses into the day roost, and scrambling back to the top before first light. It was then necessary to drive around to the bottom of the canyon to conduct observations and actuate the remote control equipment, staying 250 to 400 meters from the cliff. On the way back to the office, a stop off was made on the south rim of the canyon and the day perch inspected by telescope to determine quail utilization.

EQUIPMENT AND MATERIALS

Remote control operations were conducted with an FM encoded transmitter/ receiver/decoder system allowing up to eight discrete functions.

Model numbers of all commercial equipment are listed below:

Transmitter KTT-2-16, 49 MHz Kraft Systems*
Receiver KMR-75 Kraft Systems*
Decoder/Output Driver KMTD-8 Kraft Systems*
Camera Olympus OM-G
Film Kodachrome 64 Eastman Kodak Co.
Lens Zuiko 300 mm F4.5

Winder Olympus Winder I
Telescope Celestron 8 (2000 mm F10)
Eyepiece 25 mm

*Box 1268, Vista, California 92083

Live food consisted of pigeons (Columba livia) from the Albuquerque area, and American robins (Turdus migratorius) supplied by the New Mexico Department of Game and Fish. The dead food was Bob white Quail (Coturnix coturnix) furnished frozen by the New Mexico Department of Game and Fish.

RESULTS - Cache Cave Stocking

Quail were maintained in the cave behind the day perch for 21 days (from April 4 to April 24). Peregrines were rarely observed to use that perch. When they did, they stared at the quail but were not actually observed to remove the quail. In 1982, T. Johnson observed the female consume one of the quail, and confirmed the identity from plucked feathers. In 1983, two quail disappeared, suggesting their use. Feathers of at least one were found below a perch. If these quail resulted in two meals for the female, and she is assumed to eat two meals a day for 30 days prior to completion of egg laying, artificial caching made up three percent of her early season diet. The two meals were five percent of the food during the 21 days that the artificial cache was maintained.

RESULTS - Live Release Method

The peregrines usually pursued the released bird as soon as they saw it. Of 16 releases, 13 were pursued (81%). One non-pursuit occurred when the male was soaring above the cliff and probably did not see the release. The female declined pursuit of a pigeon released just as she passed the box and obviously saw it. On another occasion, she was perched within sight of the release, but did not pursue.

Six pigeons released with primaries tied together were not captured after energetic pursuits. Some of these were even pursued by both the male and female simultaneously. One of these was bound to temporarily by the male, but he turned loose before reaching the ground.

Two robins released with primaries tied together were pursued by the male, but not caught. Of eight blinded pigeons, five were pursued and three caught. The failure to take two was because the peregrines lost interest after a few stoops. In the case of the male, he may have been reluctant to handle pigeons after they landed on the cliff because of their size. He seemed to attack small, young pigeons more readily, but too little data exist to evaluate the size effect.

The overall result is that 19% of released birds were caught, and resulted in at least three meals for the female. Assuming two meals a day for 30 days from the start of her weight gain to the completion of her clutch, the supplemental feeding by live release contributed 5% of her meals.

The blinded pigeons typically flutter down the face of the cliff, occasionally circling out and

back, until they reach a ledge or the transition where the cliff breaks from vertical. They then begin slowly walking and flapping up the cliff. Several remained on the cliff at least 24 hours. On a few occasions, the male peregrine made a pass at these birds sometime after the release, but took none.

The average time that the first opportunity to release (peregrine flying past the release compartment) occurred was 6:57 a.m. The peregrines are active at first light, which averaged about 5:10 a.m. during the experiments. On five occasions, there was known to be a hunting flight before the first opportunity to release. The peregrines are very difficult to see in the early light, which accounts for some of the lack of release opportunity; the remaining explanation is that they are simply out of sight of or a long way from the release box.

Equipment problems, eventually narrowed down to cold sensitivity of the transmitter and a faulty antenna connection on the transmitter, occurred on five occasions, precluding experimentation each time. On one occasion, access was prevented by heavy snow.

POSSIBLE ADVERSE EFFECTS - Supplementary Feeding

Even though supplemental feeding is not a hands-on management and all potentially disturbing activities were conducted in hours of darkness, there are still several indirect avenues of potential detriment to the peregrine. The possibility of introducing disease has already been alluded to, although wild falcons in good condition are probably resistant. Another possibility is that the birds would become habituated to an artificial food source, lose the urge to forage, and slacken their hunting skills. However, artificial feeding for only a month is not likely to have an effect and the falcons will continue to hunt naturally, as experienced during this study.

An even less direct effect is that either live or dead birds not taken by the peregrines and left on ledges or in holes on the cliff might attract great horned owls (Bubo virginianus) and encourage them to seek prey on the cliff (i.e., baiting). There is some suggestion that this occurred, because a few pigeons remained on the cliff and the adult female peregrine and two young were subsequently killed by a great horned owl. However, several weeks had elapsed before the owl attack occurred and at least five young peregrines were killed by owls in the past four years without any baiting.

RESULTS - Plumage Photography

Photographs of the male and female peregrines were obtained, essentially frontal views, but with both sides of the head of both birds documented because of head turning. Lighting was by direct sunlight behind the camera and details of individual feathers are resolved on the head, upper breast, lower breast, belly, and under tail. Color is documented within the limits of film and lighting (Kodachrome type film was used because of its archival characteristics). Johnson (1983) discusses the various plumage characteristics that exhibit variation. Most of these are documented in the photographs obtained, and are sufficient to enable individual identification. The photographs provide a more specific reference than is derived by observation, but does not preclude the value of observation by an experienced observer, who can distinguish subtleties of behavior and vocalization in addition to plumage.

While the camera was installed at night to preclude direct disturbance of the falcons, the

potential existed for disturbance to occur through camera operation. Observation of the falcons by means of a high power telescope during the photographic sessions indicate that they turn their head toward the camera at the sound of the shutter. No flinching, tightening of feathers, crouching or other signs of alarm were observed, and after about half a dozen frames, the head turning response was less consistent. These casual observations suggest that this method of plumage documentation is not detrimental.

RESULTS - Early Season Prey

By telescopic observations of prey items in possession of the falcons, one robin (Turdus migratorius) one star1ing (Sturnus vulgaris) , and one red-winged blackbird (Agelaius phoeniceus) were positively identified. The robin was confirmed by Mr. Terry Johnson, and the starling was confirmed by the remote control camera, and by collection of feathers from the spot on the shelf where the bird was deplumed. Preliminary analysis of feathers collected throughout the pre-egg season identified red-winged blackbird, bluebird, white-throated swift (Aeronautes saxatalis), robin, and mourning dove (Zenaida macroura). A more complete analysis will be done by the New Mexico Department of Game and Fish. DDE contamination reported for these species is shown in Table I.

High contamination can be considered to be an order of magnitude higher than the largest value for DDE residue shown in Table I, and might be found in shore birds. Therefore, the peregrine falcon early season prey at this eyrie can be considered moderate to low in contamination level. Insufficient data exist on both the composition of early season prey and contamination levels of local prey species to assess the effect on breeding performance and the potential benefit of supplemental feeding.

TABLE I

DDE contamination of species represented in peregrine falcon early season prey (Source of DDE residue data; Enderson, 1982).

Species	Number of individuals in early Season prey	Pools analyzed (individuals)	Mean DDE Residue (ppm, wet wt.)
American Robin *Turdus migratorius*	2	7(51)	0.52
Red-winged Blackbird *Agelaius phoeniceus*	2	4(26)	0.49
Starling *Sturnus vulgaris*	1	1(7)	0.45
White-throated Swift *Aeronautes saxatalis*	1	5(39)	1.5
Mountain Bluebird *Sialia currocoides*	1?	1(11)	0.10
Western Bluebird *Sialia mexicana*	1?	1(6)	0.09
Mourning Dove *Zenaida macroura*	1	3(21)	0.21

RESOURCES

The pigeons used cost $1.00 apiece, and were fed for 19$ per month per pigeon. Wormer cost $3.30. No allowance was made for labor, amortization of the coop, or other incidentals. Lockheed Company maintained a flock of messenger pigeons for **569** per month total, presumably including all expenses (Science News, 1982). A full fledged program, releasing three pigeons a day for thirty days and assuming the pigeons were obtained thirty days prior to the start of operations, would make the total cost of the food source (using the Lockheed maintenance cost) $165.60.

While the initial cost of equipment is high, it should be amortized over several seasons and projects. The ledger sheet in the appendix details all equipment and materials. Approximately 60 hours were spent constructing, testing, and trouble shooting the equipment.

A total of 69 man hours directly related to these projects were spent in the field. Field activities consisted of observation of the falcons, equipment installation, collection of feathers, dropping quail, loading pigeons into release compartments, retrieving film, changing batteries, and setting the telescope on the day perch to determine quail utilization. Approximately 33 additional hours were spent driving a total of 1640 miles between experiment stations, and from home or office to the field.

A full fledged program of supplemental feeding at one eyrie would be a full time job for

one person for several months.

CONCLUSIONS AND RECOMMENDATIONS -Cache Cave Stocking

Cache cave stocking entails a minimum of equipment, but is unreliable because of unpredictable visitation by the falcons. The day roost cache cave is unique; similar, easily accessed cache caves cannot be expected to exist at other sites.

CONCLUSIONS AND RECOMMENDATIONS -Live Release

Live released pigeons must be handicapped to the point of blinding to enable reliable capture. Pursuit and capture was further hampered by the observer's inability to see the falcons in the early light (when the first hunting flight usually takes place), the likelihood that the falcons will be out of sight of the release box a large part of the time, reluctance on the part the male to take pigeons because of their size, and equipment problems.

Weather prevented access on one occasion, and could be expected to hamper field activities when the falcons would benefit the most from supplemental food. Cost and feeding of pigeons is small compared to the manpower required to conduct field activities. A full supplemental feeding program at one eyrie would require less than $200 for pigeons, but would entail essentially full time work for one person for two months. Equipment and travel costs would be additional. Extensive hardships from spring weather and night and early morning hours require dedication above what can be expected from volunteers.

Insufficient data exist to assess the benefit to productivity from supplemental feeding. Laboratory experiments could provide a good indication of potential benefit, and are encouraged. Smaller birds such as doves, would increase capture by the male peregrine, and some sort of throwing device would enhance visibility of the released birds. With experience, equipment problems could be minimized to the point of greater than 95% reliability. Of possible detrimental effects, baiting of great horned owls, leading to an attack on the falcons, is judged to be the most significant.

Because of possible detriment and the unknown extent of the benefit, it is recommended that supplemental feeding only be attempted at eyries where there is a known heavily contaminated early season prey base, or with a female that has a history of reproductive failure because of poor egg condition.

CONCLUSIONS AND RECOMMENDATIONS -Plumage Documentation Photography

Sufficient photographs/views of both adult peregrines were obtained to distinguish them individually. The work was carried out in parallel with other field work for little additional time and effort. If conducted independently, the photographic project would be non-negligible in these terms. Photographs obtained provide permanent reference, not subject to translation by a field observer. It is recommended that whenever a change in eyrie monitoring personnel is expected, an

attempt is made to document individual falcons with photographs.

CONCLUSIONS AND RECOMMENDATIONS -Early Season Prey Identification

Telescopic observation of prey in the possession of falcons, plucked feather collection, and remote control photography were all successful in identifying early season prey of the falcons. These methods should be continued to maximize information about prey items consumed in the period most directly affecting egg condition.

ACKNOWLEDGEMENTS

Funds for equipment were provided by the New Mexico Department of Game and Fish, Game Protection Fund. Film, processing, and mileage reimbursement were provided by DOE funding to the Los Alamos National Environmental Research Park, administered by Group LS-6. John Hubbard provided encouragement and suggestions. Terry Johnson helped with the field work, and offered insight into peregrine behavior and ecology.

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APPENDIX

EQUIPMENT AND MATERIAL EXPENSE LEDGER

	Items	Cost, $
1/18/83	3/8 Exterior Plywood	14.24
1/18/83	Fasteners, Misc.	1.00
1/20/83	Solenoids, 4 ea @ $1.25	5.00
2/14/83	Wire -Zia salvage	2.80
2/15/83	Springs and Hinges -Alwoods	7.88
2/17/83	Wire -Zia Salvage	4.00
2/24/83	Electrical Hardware -Zia Salvage	0.95
2/25/83	Electrical Hardware -Radio Shack	20.51
3/4/83	Pigeon Feed and Wormer -Chaparral Sales	13.83
3/4/83	Plugs -Radio Shack	1.34
3/4/83	Electrical Hardware	32.58
3/7/83	Weatherproof camera bags (2 ea. @ $26.37) 52.74	52.74
3/12/83	Pigeons, 6 ea @ $1.00 (Pellette)	6.00
3/12/83	Paint -Gibsons	3.43
3/10/83	Wire -Zia Salvage	6.00
3/14/83	Ammo Boxes (2 ea) -Surplus City	18.74
3/16/83	Pigeons, 10 ea @ $1.00 -McCracken	10.00
3/17/83	Tubing and Rivets -Metzger	3.31
3/31/83	Transmitter, 2 receivers, 2 decoders -Kraft Sys	1040.00
4/2/83	Tubing -Metzger	0.71
4/6/83	Pigeons, 10 ea @ $1.00 -McCracken	10.00
4/18/83	Relays	8.31
	TOTAL	1263.37

Film, processing, and batteries furnished by Los Alamos National Laboratory and the camera equipment and High Power Telescope owned by the author are not included above.