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ANALYSIS OF THE BIRD-STRIKES TO EX-SOVIET UNION AIR FORCE IN EAST GERMANY, 1970-1981, 1985-1991

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Summary

Data on 496 birds-strikes with respect to months of a year, time, weather conditions, type of aircraft, altitude, speed and phase of its flight. place of impact and bird species are presented. The number of prematurely removed engine fighters and 4 pilots were killed are described. Reasons of considerable reduction of the number of accidents and damaged of engines in 1985-1991 in comparison to 1970-1981 are discussed. Data cited annual approximate loss Soviet Union Air Force as a result of bird-strike till 1989 in results accldents, catastrophes and changed engine for repair and annual loss in military and civil aviation of the whole COUnL'y.

Key words: analysis, military aviation, bird strike.

Place	MIG 23	MIG 25	MIG 27	MIG 29	SU 7	SU 17	SU 24	MI 2	MI 6	MI 8	MI 24	YaK 28	AN 12	TU 16
6. Domgarten	6		1	4										
7. Faltenberg	3			5										
8. Finsterwalde	1		11											
9. Finow	4	4		3		1		1						
10. Grossenheim	1		3				4							
11. Këten	4			3										
12. Lerc			7											
13. Malvinom										1				
14. Merseburg				7										
15. Noi-Ruppin						8								
16. Noi-Valcov		1					7					6		
17. Nors									1	1	3			
18. Oranienburg										3	1			
19. Parchim										1	4			
20. Sperenberg										2			2	1
21. Stendal										2				
22. Templin						2								
23. Vernoichen	2	1		1										
24. Vitstock	4			4										

Apparently, some of peculiarities of bird habitat their migration and aircraft flight at or near airfields determine collision with swan at No 20 (see Tabl. 1); with heron flock at No 1; geese flock at No 1, 2, 15; Lapwings at No 3; raptors at No 4, 7, 10, 15; pheasant - No 17: owl - No 20; gulls - No 14, 19, 23(2); starlings - No 7, 18; ducks - No 4, 19; pigeons - No 1, 12, 14, 19; lark - No 1, 6; sparrows - No 10, 15, Swallows - No 1.

3. Distribution by time of year

As our former investigations have shown (Jacoby, 1991a) birds that closely approach to aircraft at short distance for the first time cannot avoid collision and become more often victims of collisions. Usually, they were migrants or juveniles. Adult birds that nested and/or rested on aircraft. They are very rare victim in bird-strike events. The first peak of collision took place during spring migration, in March – April (Fig. 3). Later, at the end of migration and beginning of the breeding period, some decrease of collisions number was observed. The number of bird-strikes increased in June after fledging of chicks in most bird species and peaked in the second time in August when mass post-nesting nomadic and fall migration began. In September-October migration level remained sufficiently high and collision number approached to its spring level.

Usually, both altitude of flight and size of flocks increased during autumn migration.

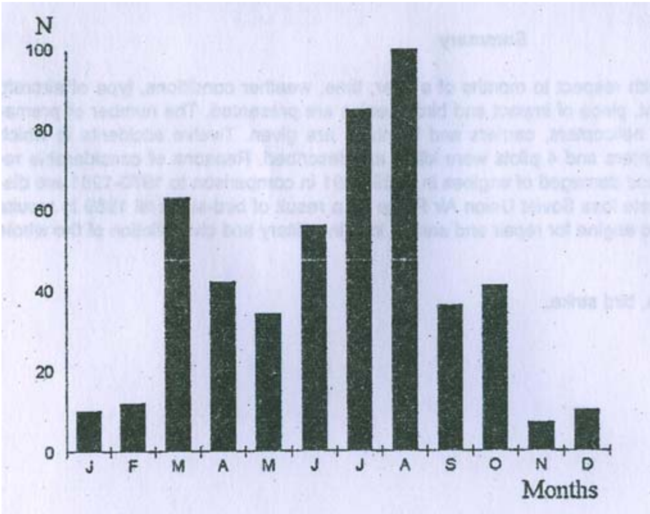
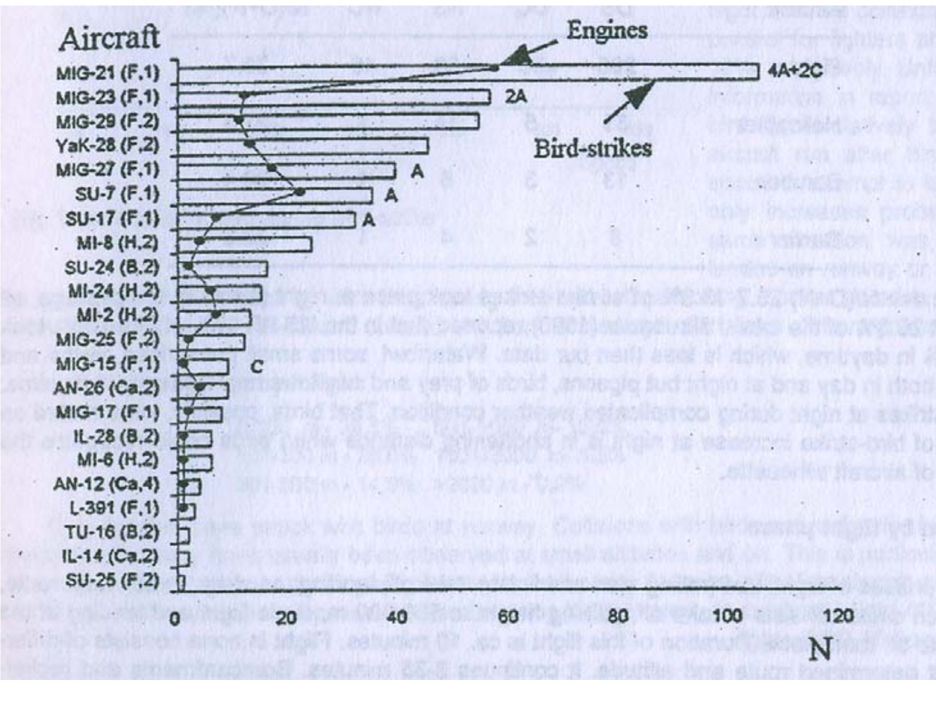


Fig. 2. Bird-strike number relatively to months of years

Introduction

Data on collisions of bird with aircraft of the former Soviet Union Air Forces (SUAF) in East Germany are presented as a data of Meteorological Service of Air Forces, which provides meteorological and omithological safety of aircraft flights. Data received have got some shortcomings. There are no data on period from 1982 to 1984; names of air-bases and helicopter landing grounds are given only for period since 1985; bird species in many cases were unknown. Besides specific interest for Russia Air Forces these data are possibly of interest to German colleagues who connect with usage former military airdrome for civil aircraft

1. Aircraft involved in bird-strikes



Being the most numerous and long-used single-engine fighter, MIG-21 struck birds more often (Fig. 1). Other single-engine fighters (MIG-23, MIG-27, SU-7, SU-17) have got only rare accident (Fig. 1). Two-engine fighters (MIG-25, MIG-29, YaK-28), helicopters, carriers and bombers have no accidents at all. Fighter MIG-29 and helicopters MI-8 and MI-24 landed by use of only one engine after stopping the other one. Helicopter MI-24 made successful forced landing when both of its engines stopped after striking flocks of big birds. On Altenburg air-base fighter MIG-29 struck flock of herons at an altitude of 250 m and damaged both engines. It had landed successfully, but engines have to be removed. Fighter MIG-21 after bird-striking and stopping its single engine near runway at height of 15m could successfully land but the engine was removed from service to repair. On comparing the number of removed engines and bird-strikes it is possible to say that they do not depend on type of aircraft.

2. Air-bases: collisions of aircraft with different bird species

Table 1. Number of bird-strikes on different air-bases in 1985-1991

Place	Aircraft													
	MIG 23	MIG 25	MIG 27	MIG 29	SU 7	SU 17	SU 24	MI 2	MI 6	MI 8	MI 24	Yak 28	AN 12	TU 16
1. Altenburg	4	1	6	11	2									
2. Altes-Lager	4			5						1				
3. Altstedt						3								
4. Brandt			5	4			5							
5. Cerbst	3			3										

Condition is good altitude of bird flight increased both during in day- and at night-time. Five-tenfold decrease in the number of bird-strikes took place in winter (November - February), which consists only about 8% of all birdstrike events. This months' distribution of bird-strikes is similar to Czechoslovak Airforce (Murar, 1994) and in ex-DDR aviation ones (Vernike, 1991).

4. Distribution by time of day

Information on bird-strikes according time (day (D) and night (N)) and weather condition is presented on Table 2. Simple weather condition (S) is determined as a large visibility distance, high clouds or clear sky. Complicated weather condition (C) is connected with low unbroken clouds and short distance of visibility. Sometimes bad visibility has noticed in twilight and at dawn.

Table 2. Bird-strike distribution in connection with time and weather condition

Aircraft	DS	DC	NS	NC	N/(D+N)(%)
Fighter	205	90	56	46	25.7
Helicopter	35	5	14	1	27.3
Bomber	13	3	6	1	30.4
Carrier	8	2	4	1	33.3

According to the index N/(D+N) 25.7-33.3% of all bird-strikes took place at night (Tabl.2). On average, all night collisions consist 26.3% of the totals. Neubauer (1990) reported that in the US AF 17% of bird-strike took place at night and 5% in daytime, which is lees than our data. Waterfowl, some small passerines, swifts and waders could migrate both in day and at night but pigeons, birds of prey and swallows migrates only in daytime. There are some gull-strikes at night during complicated weather condition. That birds, possibly, were rested on runway. Basic cause of bird-strike increase at night is in shortening distance when birds could recognize the aircraft and invisibility of aircraft silhouette.

5. Distribution by flight phase

There exist some phases of flight: taxi (rolling start and finish), take off, landing, on circle, in zone, on route, fairing ground. Flight on circle consists of take off, gaining height to 500-600 m, circle flight and landing at the same place where take off took place. Duration of this flight is ca. 10 minutes. Flight in zone consists of-different pilotage figures at determined route and altitude. It continues 3-35 minutes. Bombardments and rocketshooting are carry out at firing ground from different heights with or without diving on ground targets. Because of difference in flight characteristics of fighters, bombers, carriers and helicopters, their flight phases have been considered separately (Tab. 3).

Table 3. Bird-strike distribution by flight phase

Aircraft Phase	Taxi	Take off	On route	Zone	Circle	Firing ground	Landing	Landing/ take off
Fighter	16	33	46	14	42	7	106	3.2
Bomber		1	9	1		1	3	3.0
Helicopter		4	31		10	4	6	1.5
Carrier		5	4		1		5	1.0

Fighters and bomber struck birds during landings as 3.2 and 3.0 times often than during taking off, respectively (Tab. 3). This index is 2.3 in the US Air Forces (Neubauer, 1990). This author stated that a noise during take off grows. It is difficult for bird to find an aircraft when it landed: it moves from above and noise during landing is less than during taking of. Apparently the same description can see for our data.

Most bird-strikes occurred when aircraft flew on circle or turned. It is difficult for birds to anticipate speed and direction of aircraft flight to avoid collision with them. They are consist for fighters and helicopters 16 and 18%, receptively. Unfortunately, there is no information in report form on direction of bird flight relatively to aircraft or whether aircraft run after bird. Bird increases its speed in attempt to escape, but this action only increases probably of collision. The same situation was caused when birds landed on runway or take off against wind. In such case aircraft catch up with birds during their take off or landing. Similar situation was observed by pilot who landed his carrier AN-12 and collided with flock of starlings which take off from ground (Jacoby, 1991b).

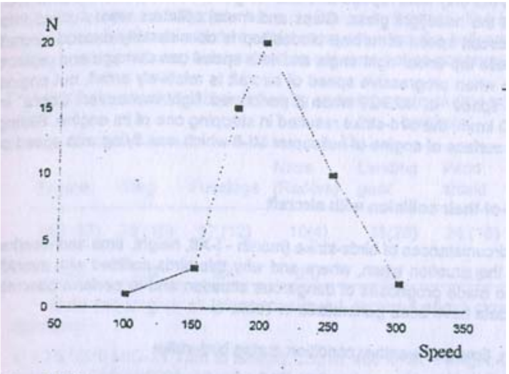


Fig. 3 Helicopter speed during bird-strike

6. Distribution by height

0-100 m-39.5% 501-1000 m- 12.6%
101-300 m - 26.6 % 1001-2000 m- 5.5%
301-500m-14.9% >2000m-0.9%

Only fighters have struck with birds at runway. Collisions with birds searching for food at airfield or along margins of runway have usually been observed at small attitudes and on. This is particularly true for swallows, sparrows, gulls, pigeons, partridges, pheasants and owls. At large altitudes aircraft collided with migrating ducks, geese, waders, small passerines and soaring birds of prey. At maximal height 4000 m take place crush fighter MIG-15 from bird strike.

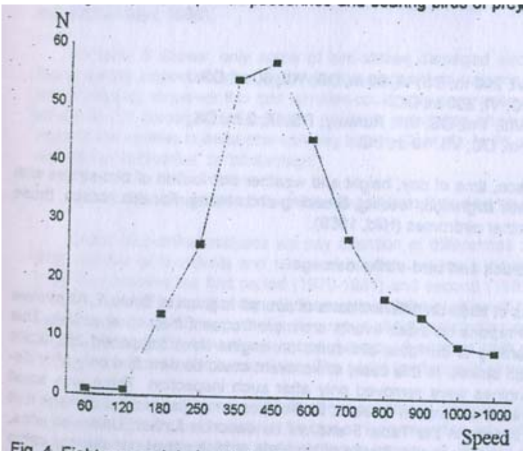


Fig. 4. Fighter speed during bird-strikes

7. Distribution by aircraft

In military aviation most of birdstrikes occurred at relatively low altitudes when aircraft is flying well below their cruising speed. For example, over 76% of all strokes of fighters with birds occurred at speed 250-700 km/h (Fig.). Over 88% all bird-strikes of helicopters mostly occurred on-route when their speed is 180-250 kmrh (Fig.).

Minimal speed (60 and 120 km/h) when fighter struck swallows have been noticed at taxiway and at beginning of rolling start at runway. Most of collisions on runway and at small heights have happened with little birds (swallows larks, sparrows), which usually did not damage a fighter. However if speed of flight increased engines could be damaged; 6 engines were removed as a result of such collisions with small birds. Apparently damage of umpetuously rotating engine turbine blades depends not only from speed and bird weight but from place of stroke too.

So, in one case impact of small bird braked the headlight glass. Glass and metal splinters were sucked into fighter engine and damaged it Sometimes circuit speed at turbine blades top is considerably exceed aircraft speed. Therefore bird impact in more thin blade top under right angle and with speed can damage and replace engine for repair. Such situation takes place when progressive speed of aircraft is relatively small, but engine works at maximal power. For example, the speed of MIG-29 when it performed flight maneuver "cobra" in Paris Le Budget before the accident was 180 km/h; the bird-strike resulted in stopping one of its engine. Sliding stroke of swan made only small dent on the surface of engine of helicopter MI-8 which was flying with speed of 220 km/h.

8. Birds and some circumstances of their collision with aircraft

Identification of bird species and some circumstances of birds-strike (month - I-XII, height, time and weather conditions, as in Tabl. 2) permits ascertain the situation when, where and why this birds collided with aircraft. According to this information it is possible to made prognoses of dangerous situation and to perform concrete works to prevent bird-strike. Such complex data have been generalized in Table 4.

Table 4. Bird species, height, month, time and weather condition during bird-strike.

Duck. III, 900 m, NC; V, 500 m, NC; VII, 80 m, DC; X, 9 m, NS; X, 200 m DC.
Goose. M. 300 m, DC; lII, 1500 m, DS, X, 70 m. DS; XS, 120 m, DS.
Mute Swan. 1, 200 m, DS.
Bird of Prey. IV, 1200 m, DS; VI, 200, DS; VI, Runway, DS; VII, 5 m, DC; VII, 200 m, DC: VII, 150 m, DS; VII, 25 m; DS; VII, 300 m, OS.
Partridge. III, Runway, NC; V, Runway, NS; VII, Runway, NC.
Pheasant. IV, 10 m, NC.
Gull. 1, 10 m, DC; IV, Runway, DC: VII, 90 m, DC: VIP, 200 m, DS: Vii, 600 m, DG: VII, 100 m, DS, X, Runway, NC.
Lapwing. VII, 300 m, NS; X, 250 m, DC.
Owl. VI, Runway, NC; V, Runway, NC.
Heron. X, 250 m, DS.
Pigeon. Il. 100 m, DC; II, 70 m, DC; IV, 100 m, DC, VII, 200 m, DS; VIII, 100 m, DC; VIII, 200 m, DS; X, 100 m, DS.
Swift. V, 300 m, DC; VIII, 100 m, DC.
Thrush. 1, 30 m, NC.
Crow. I, 70 m, DC;
Rook. lll, 900 m, DC.
Starling. III, 200 m, Twilight; V, 600 m, DS; VI, 200 m, DS; VI, 60 m, DS; VIll, 80 m, DS.
Lark. Ill. 15 m, DS; VI, 10 m, DC; VI, 8 m, DC: VI, 200 m, DC.
Swallow. VI, 100 m, DS; VIII, Runway, DS; VIII. 1 m, DS; VIII, Runway. DS; IX, 2 m, DS.
Sparrow. III, 15 m, DC; VIII, 200 m, DC: IV, 6 m, DC, VIP, 10 m, DC.

Analysis of these data shows that season, time of day, height and weather distribution of bird-strikes with relation behaviour of birds connected with their migration, feeding, breeding and resting. For this reason, these data coincide with similar ores received at other airdromes (Hild, 1969).

9. Distribution by aircraft parts struck and bird-strike damage.

All information on distribution of impacts of birds on different parts of aircraft is given in Table 5. All strokes on engines are most dangerous. Therefore reports on these events are more frequent than other strikes. This is important for single-engine fighter. According to our data bird-strike on engine have happened 263 times (53 0%) Sometimes pilot did not notice such strikes. In this case, strike event could be detected only after detail engine inspection. Forty-two of 171 engines were removed only after such inspection. There was small damage of air-intake, but no one of engine were suffered in 9 cases. Bird-strikes on engine did not damage it at all in 83 cases. Twenty accidents did not include in the Table 5 and will be describe further. Unlike engines, strokes in cabin glass were noticed by pilot in many cases. Stroke of big birds at high speed can destroy cabin glass and kill the pilot According to our data stroke of pigeon destroyed a cabin glass of helicopter MI-2 and MI-8 Strokes of birds on cabin glass could injure it: scrabe in grass (MIG-29), crack of cabin glass (MIG-23) and destruction of a part on glass (MIG-15. MIG-27, MIG-23; in the late case fighter collided with bird of middle size at speed 1050 km/h). All of this bird-strikes in cabin glass are very dangerous. Little damages of top part of carrying blades of helicopter have registered in 9 cases. But in one case collision with large bird destroyed some of screw blade which result in strong vibration the helicopter. Bird-strikes on other aircraft part (wing, fuselage, nase, radome, antenna and so on) were not so dangerous as stroke on engine or cabin glass.

Table 5. Distribution of bird-strikes by aircraft part struck (the numbers of strikes without damage are given in brackets)

Engine	Wing	Fuselage	Nase (Radom)	Landing gear	Wind shield	Tail	Helicopter blade	Other install	Unknown nil damage
263 (83)	39 (16)	17(12)	10(4)	33(28)	24(15)	3	10	21	76
53.0	7.9	3.4	2.0	6.7	4.8	0.6	2.0	4.3	15.3

Allow me to give all information that I obtained about circumstances of 12 fighter accidents in Eastern Germany.

1. 7.10.1970 MIG-21 Turn to landing. 250 m, 400 km/h. Twilight. Lapwings. Stop engine, 1 pers. ej. Allstedt.*
2. 23.12.1970. MIG-21. After take off. 200 m. Loss of height. NS. Big bird. 1 pens. ej.
3. 510.1971. MIG-21. Zone 1000 m. DS. 1 pers. kill.
4. 4.04.1972. MIG-15. Zone 4000 m, above clouds, DC. Flight on double control. 2 pers. kill".
5. 22.07.1974. MPG-21. Landing, 100 m. Over remote radiodriving station. 1 pers. Ej. NC***
6. 27.02.1975. SU-7U. Fair ground, 2000 m. 460 km/h. DS. 2 pers. ej.
7. 7.07.1975. MIG-21. On route. 1100 m. Bird flock. DS. 1 pers. ej.
8. 8.04.1977. MIG-21. On circle. 600m DS. 1 pers. kill.
9. 21 05.1977. MIG-27. Fire ground. 600 m. go out from diving. Starlings. DS. 1 pers. ej.
10. 18.05.1978. MIG-23. On route to fair ground. Weather air reconnaissanee. CS. 1 pers. ej.
11. 22.10.1990. SU-17. Take off. 70 m. Geese flock. Stop engine. DS. 2 pers. ej. Noi-Ruppin.
12. 19.11.1991. MIG-23. Approach 120 m. 380 km/h. Goose. Stop engine. 2 pers. ej. Altos-Lager (Juterbog)*

* Richardson (1996)
** the reason of crush could be in windshield destruction after geese and duck striking;
*** analogical conditions and results have noticed in night swift-strike to MIG-21 10.7.1982 Borisoglebsk, Russia (Richardson, 1996).

As table 5 shows, only some of bird-strikes damaged aircraft. Possibly some of bird remains that was found during inspection after flight take into account as occurring in landing. It can increase the collision number at landing, However this bird remains could stay on chassis after take off too. 62.5% of bird-strike in windshield do not damaged it. Strokes in separate installation often noticed only in cases of their damage. It is related to the strokes in helicopter carrying blades (Tabl. 5). In 76 cases place of struck have not been mentioned except for "bird-strike" or "nil damage".

10. Comparison bird-strike hazards to aircraft during two periods, 1970-81, 1985-91.

Under bird-strike analyses we pay attention at differences between 1970-19781 and 1985-1991 periods. Both number of accidents and removed engines are main indexes which characterize danger of birds to aircraft. To compare the first period (1970-1981) and second (1985-1991) periods we used some more indexes (Tabl. 6). It was found that annual observation of the number of bird-strikes in the first period is less than in the second one (Tabl. 6). Apparently, it is result of full registration of all bird-strikes including number undamaged engines (P1-59, I-25). However number of removed engines both per year and per 100 bird-strikes in first period were greater than in the second one. The same tendency is observed for too (Tabl. 6).

Decrease of collisions result from not only more complete registration of all bird-strike and exploitation of two engine fighters but measures for bird-strike prevention as well During intensive training flights, group of 3-4 solder prevented birds from approaching to runway or landing on it with help of rocket pistolscare. To avoid Striking during mass migration aircraft that flight in zone to be out of bird migratory current used aircraft radar and visual observation and changed height and place of flight.

All of these measures are not effective against small passerine birds flying across airdrome and birds of prey soaring above airdromes. In the some time small birds are less dangerous for aircraft It is describes increase of bird-strikes and in the some time decrease bird dangerous for aircraft.

Table 6. Indexes of bird-strike hazards to aircraft

Period	Total number of strikes	Mean per year	Total number of engine changed	Mean per year	Engine changes/ 100 strikes	Number of acci-dent	Mean per year	Accidents/ 100 strikes
1970-81	284	23.6	124	10.3	43J	10	0.83	3.52
1985-91	212	30.2	47	6.7	222	2	0.29	0.94

To improve identification of bird species after collision in 1995 Russian Ministry Defense and Air Force published practical manual 'Atlas-manual of bird species identification on their macro- and microstructure fragments". The former SUAF are reported in this book to have lost after bird-strikes (5-7 accidents and catastrophes, 150-200 prematurely removed engines) several tens of million USD annually before 1989 Newspaper "Krasnaya Zvezda" of 11.03.1995 reported that annual loss in SUAF was more 50 million USD. In the same newspaper of 15,01.1989 major-general Litvinov, Chief of Meteorological Service of SUAF, reported that annual loss of all aviation both civil and military, near one milliard USD. Likely, this 19 years Ioss SUAF in East Germany from bird-strikes 171 removed engines and 12 accidents have compared with mean annual loss through engine change, and in two times more mean annual loss owing to accidents in all SUAF.

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